Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 917
Joint Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
and the
Office of Farm Management and Farm Economics
H. C. TAYLOR, Chief

Washington, D. C. ▼ March 11, 1921

FARM PRACTICE IN GROWING FIELD CROPS IN THREE SUGAR-BEET DISTRICTS OF COLORADO

By

SAMUEL B. NUCKOLS, Agriculturist, Office of Sugar-Plant Investigations, Bureau of Plant Industry, and
THOMAS H. SUMMERS, formerly Scientific Assistant, Office of Farm Management and Farm Economics

CONTENTS

	Page
The Districts Studied	1
Method Used in Collecting Data	3
Soil Types of the Region	3
Climatic Conditions	4
Seasonal Distribution of Labor	6
Farm Practice	11
Preparation of the Seed Bed	12
Planting	19
Manurial Practice	21
Cultivation	24
Irrigation	27
Harvesting	33
Marketing	40
Cost of Production	42
Summary	51

WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 917

Joint Contribution from the Bureau of Plant Industry, WM. A. TAYLOR, Chief, and the Office of Farm Management and Farm Economics, H. C. TAYLOR, Chief.

Washington, D. C. ▼ March 11, 1921

FARM PRACTICE IN GROWING FIELD CROPS IN THREE SUGAR-BEET DISTRICTS OF COLORADO.

By SAMUEL B. NUCKOLS, *Agriculturist, Office of Sugar-Plant Investigations, Bureau of Plant Industry,* and THOMAS H. SUMMERS, formerly *Scientific Assistant, Office of Farm Management and Farm Economics.*

CONTENTS.

	Page.
The districts studied	1
Method used in collecting data	3
Soil types of the region	3
Climatic conditions	4
Seasonal distribution of labor	6
Farm practice	11
Preparation of the seed bed	12
Planting	19
Manurial practice	21
Cultivation	24
Irrigation	27
Harvesting	33
Marketing	40
Cost of production	42
Summary	51

THE DISTRICTS STUDIED.[1]

In 1915 and 1916 a study was made of the farm practice in growing sugar beets in three districts of Colorado. These data were published in Department Bulletin 726. In the summer of 1918 these districts were revisited and data obtained for the 1917 farm year, showing the farm practice and labor requirements in handling the crops grown in rotation or in competition with sugar beets.

It is believed that this information will show not only the comparative requirements of labor, materials, etc., for the various crops, but also how these crops fit into the rotation system in these areas.

An attempt has been made to present the comparative cost of producing these crops. Many items of cost in 1917 were abnormal, but as many of these enter into the production of all crops, the opportunity for comparison remains the same.

The data presented were worked out from 328 records. The distribution of these among the various crops is shown in Table I.

---

[1] Acknowledgment is due to Miss Catherine Hawley, of the Office of Farm Management and Farm Economics, for careful work in supervising the tabulations which have been used in this bulletin. Thanks are also due the farmers of these districts for their hearty cooperation in giving complete estimates concerning the man and horse labor requirements and other costs of producing the crops included in this study.

TABLE I.—*Crop enterprise records obtained in Colorado in 1918.*

[The data collected pertain to the 1917 crop year.]

District.	Number of records obtained.[1]								
	Alfalfa.	Barley.	Wheat.	Oats.	Beans.	Corn.	Potatoes.	Cantaloupes.	Cucumbers.
Greeley	36	33	9	15	58	5	46		
Fort Morgan	35	22	7	12	2	2			
Rocky Ford	25		6	10	14	3		16	16
Total	96	55	22	37	74	10	46	16	16

[1] The 46 potato records which have been included in this study were obtained by the Office of Farm Management in a preliminary survey of the cost of producing potatoes during the years 1912 and 1913. These potato-enterprise records were taken in Weld County, Colo., by Mr. H. H. Clark.

The importance of the various crops is reflected to some extent in the number of records obtained in the three districts. For instance, alfalfa is an important crop in all areas, while potatoes were relatively unimportant except in the Greeley district. Again, cantaloupes and cucumbers are grown commercially only in the Rocky Ford district, while barley is not grown to any great extent there. Although corn is increasing in importance in all the areas, this crop in 1917 was relatively of very little significance. The districts covered in this work are shown on the map (fig. 1).

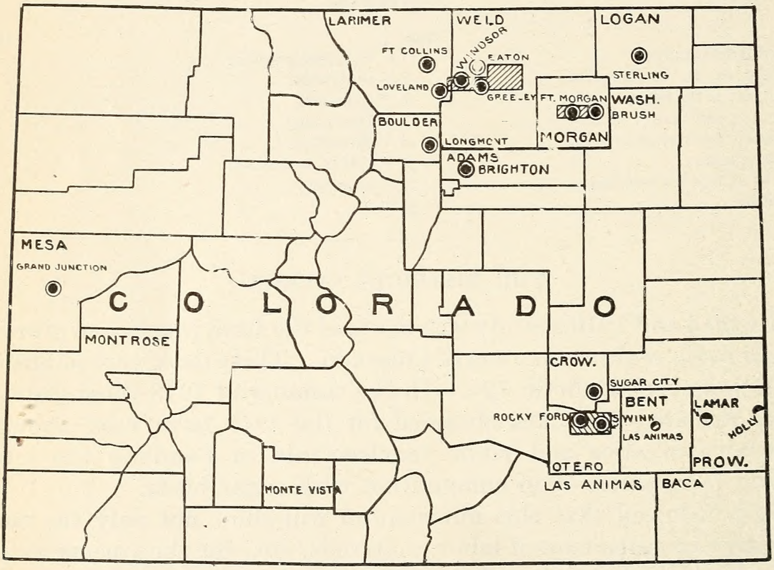

FIG. 1.—Map of Colorado, showing the three districts included in this survey (areas with diagonal lines) in Weld, Morgan, and Otero Counties. The location of each sugar factory operating in 1917 is shown by a black dot within a circle. Each factory idle in 1917 is shown by a circle half black and half white. The factory formerly operated at Holly, Prowers County, has been removed.

METHOD USED IN COLLECTING DATA.

The survey method was used in collecting the data presented in this bulletin. In many instances items were taken directly from actual records; in other cases estimates were obtained. Experienced investigators visited the farmers and held personal interviews. Whenever any doubt was entertained as to the accuracy of a record, the data were discarded. The results obtained represent the experience of the better farmers in these districts and therefore show the common methods employed in the production of farm crops.

SOIL TYPES OF THE REGION.

The soils of these districts are, as a rule, deficient in organic matter, but high in available mineral plant food. Commercial fertilizers are not generally used in these regions. Such experimental work as has been done with prepared fertilizers has not proved them profitable for general use. The soil of different parts of these areas varies considerably, but as a rule it is a sandy loam, most of it being well adapted to the growth of such crops as alfalfa, sugar beets, beans, cantaloupes, cucumbers, and small grains. The more sandy or open types of soil are especially adapted to the growing of potatoes.

The Bureau of Soils of the United States Department of Agriculture has made soil surveys of areas in the Greeley and Rocky Ford districts.[1]

Colorado fine sandy loam is the prevailing type of soil of the Greeley district, but the range of soils is from the Colorado sand to Colorado adobe. The Colorado fine sandy loam of the Greeley district consists of a fine sandy loam of approximately 3 feet, underlain by a heavier sandy loam which increases in clay and silt content as the depth increases. The soil is well drained and free from seepage water.

Agricultural methods are primarily the same for the same crop in a given district, but the farmer tilling the soil that is less easily handled must exercise greater care in its preparation and cultivation. These soil variations also affect the selection of crops for the farm and often determine the acreage of a particular crop to be grown. The adobe and heavier soils require that greater care must be taken in the preparation of the seed bed, and consequently they oftentimes show a greater cost for producing the crops.

In the Arkansas Valley 70 per cent of the area surveyed consists of two soil types—the Fresno fine sandy loam and the Maricopa sandy loam. The Fresno sandy loam has a fine silty texture, is yellowish in color, and extends to a depth of 6 feet. This type of soil is especially well adapted to the growth of row-tilled crops and those requiring a good seed bed, as it is a soil that is not inclined to bake or crust and is easily kept in good tilth. The Maricopa sandy loam has a more open texture, and water soaks rapidly into the ground. This requires greater skill in the application of irrigation water. This loam is underlain by a compact subsoil, which has a tendency to cause seepage in some low spots, but it is a soil that retards the movement of water from the irrigation canals and ditches. The Maricopa sandy loam and the Fresno fine sandy loam are well adapted to most of the crops commonly grown in the Arkansas Valley.

---

[1] Holmes, J. G., and Neill, N. P. Soil Survey of the Greeley area, Colorado. U. S. Dept. Agr., Bur. Soils, Field Oper., 1904, p. 951–993, fig. 40. 1905. Lapham, M. H., and party. Soil survey of the lower Arkansas Valley, Colorado. U. S. Dept. Agr., Bur. Soils, Field Oper., 1902, p. 729–776, pl. 46, 53, 3 folding maps. [1903.]

In the selection of a soil for the growing of crops in an irrigated region, it is necessary to have one that has good drainage, especially subsoil drainage. A soil for irrigation should not be too compact or water will not penetrate it quickly. Such a soil is also likely to crust or bake when irrigated or after a hard rain. Most of the soils of this semiarid region are high in mineral fertility, and the problem of selection is in regard to their water absorbing and holding capacity, as water is most often the limiting factor in maximum crop production.

CLIMATIC CONDITIONS.

A limited rainfall (Table II) of approximately 13 inches a year, a low atmospheric humidity, occasional high winds, and but few cloudy days are the characteristic features of the Colorado climate. These conditions cause a rather heavy evaporation of moisture from the soil. In order to produce crops, irrigation is practiced in regions where there is an available supply of water for this purpose. The principal irrigated sections are located in the valleys and drainage section of the South Platte River in northern Colorado and of the Arkansas River in southern Colorado. Rocky Ford was selected as typical of the southern section and the Greeley and Fort Morgan districts as typical of the northern section.

TABLE II.—*Average annual rainfall of two sugar-beet districts in northern Colorado and one district in southern Colorado.*

[Depth of rainfall expressed in inches.]

Month.	Greeley.		Fort Morgan.		Rocky Ford.	
	1888 to 1915 (mean).	1917 [a]	1892 to 1917 (mean).	1917	1888 to 1917 (mean).	1917
January	0.30	0.10	0.24	0.45	0.25	0.17
February	.46	.18	.44	.22	.35	.22
March	.86	.40	.75	.25	.56	.35
April	1.66	....	1.84	.40	1.68	.99
May	2.64	....	2.36	7.14	1.85	1.62
June	1.45	....	1.84	1.33	1.32	.25
July	1.83	....	2.48	1.02	2.60	1.60
August	.93	....	1.63	2.31	1.45	1.18
September	.92	....	.93	1.53	.87	2.45
October	.89	.62	.92	.49	.84	.12
November	.32	.09	.29	.30	.41	0
December	.44	.28	.39	.24	.49	0
Total annual precipitation	12.70	....	14.06	15.68	12.67	8.95
Altitude—feet	4,639	....	4,338	....	4,177	....

[a] Data incomplete for 1917.

Some of the crops studied can be grown without the practice of irrigation in the semiarid climate of Colorado. However, to reach the maximum yield it is necessary to irrigate. There are other crops which can not be grown at a profit except by irrigation. Sugar beets are never grown in this region without irrigation, and cantaloupes and cucumbers are not commercially profitable without it. Beans, potatoes, and small grains are grown on both irrigated and nonirrigated lands at a profit, with the average production per acre much greater on the irrigated areas.

Precipitation and the seasonal distribution of rainfall are much the same for the two valleys. Fortunately, the major portion of the annual rainfall occurs during the growing season. There is a somewhat heavier rainfall in the months of March, April, and May in the South Platte Valley than at Rocky Ford. (See Table II.) This with the slightly increased temperature of the Rocky Ford district accounts partially for the fact that it is customary there to irrigate immediately after or previous to planting some crops. (Fig. 2.) The Greeley and Fort Morgan growers do not practice spring irrigation, as there is, as a rule, sufficient precipitation or stored moisture in the soil to germinate the seed and start the crops.

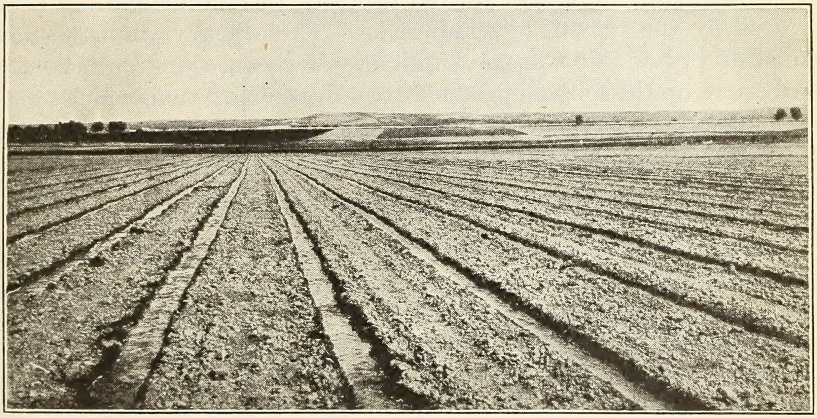

FIG. 2.—Watering sugar-beet seed for germination, showing an example of row irrigation. The furrows must be well made, and careful attention should be given to the running of the water. The furrows are made as the seed is planted.

Some rains which fall during July, August, and September do not benefit the crops greatly; in fact, they may do serious damage by forming a heavy crust or by causing the crop to lodge. Many of these rains come in heavy showers, when the run-off is great, and others in light showers which do not penetrate the soil. The average being very low, the evaporation is rapid and excessive. In some years, because the winter rains are light, the fields remain dry and hard and are in such poor condition in the spring that unless irrigation is practiced the seed germinates slowly and unevenly.

The Greeley district is close to the mountains, and the mean annual temperature there is 47° F., as compared with 51° for Fort Morgan. The range between extremes is wide. The nights are cool and the days, as a rule, are warm. The summer temperatures of the Rocky Ford district are somewhat higher than those of the Fort Morgan and Greeley districts. Throughout the entire territory cloudy days are the exception.

High winds, which are a characteristic feature, usually blow with great persistence in the spring, when the fields are without vegetation. Thus, it is a common occurrence for loose soil to be picked up and carried along with each strong current of air. If one of these heavy winds occurs when the plants are small and the soil is dry, much damage may be done to the crop. The seed is sometimes blown out or too deeply covered. Plants are left with their root systems exposed or covered by deposits of dust. At other times the sand carried by the wind cuts the tender plant leaves. Windstorms often damage a young crop to such an extent that it is necessary to reseed it. In some of the longer settled districts this difficulty has been reduced by the growth of windbreaks. These heavy winds accompanied by a low atmospheric humidity often cause the formation of hard crusts on the soil and produce excessive evaporation, which tends to counteract all the beneficial effects of a rain. Cultivation as soon as possible after rainfall is essential for the best results.

SEASONAL DISTRIBUTION OF LABOR.

Before a cropping system can be intelligently established on the farm, it is necessary to study the distribution of labor by months for the various crops in the proposed plan. Certain crops must be planted at the same time, and therefore the land must be prepared at the same time; others must be cultivated simultaneously; while others must be harvested during the same period. In fact, every operation on two or more crops may conflict with others. It is necessary then to plant only as many acres of these crops as can be handled by the available labor.

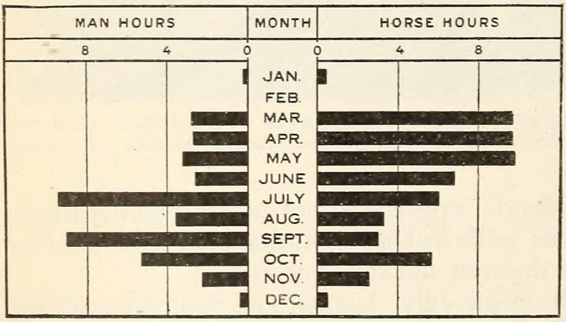

FIG. 3.—Labor distribution by months in growing field beans in the Greeley district of Colorado.

In the diagrams presented (figs. 3 to 8), no crop has been considered for more than one district. Although there is a slight difference in the dates of the various operations in the three districts, the distribution over the year is practically the same. The labor in growing small grains and sugar beets is tabulated for the Fort Morgan district; beans, potatoes, and alfalfa have been worked out under the conditions at Greeley. The cantaloupe and cucumber data pertain to the Rocky Ford district, which is the only area studied where these crops are produced commercially.

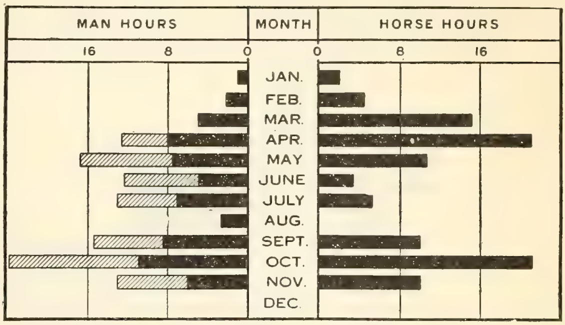

FIG. 4.—Labor distribution by months in growing sugar beets in the Fort Morgan district of Colorado. The lines of hatching represent contract labor.

The accompanying diagrams showing the seasonal distribution of labor have taken into consideration only the work done in growing the farm crops. No study has been made of the live-stock enterprises on these farms from the standpoint of labor distribution. Attention has been given to the overhead labor expense, which is a miscellaneous labor charge common to all farms, not definitely connected with any given enterprise, but chargeable to the farm as a whole.

The enterprise survey has been used only to a limited extent as a basis for the study of the seasonal distribution of labor. Such data have usually been obtained by the use of complete labor records of farm operations. The enterprise survey has made available information relating to labor distribution upon a comparatively large number of farms, and the records thus obtained carry suggestions concerning the utilization of labor in growing crops and provide relatively accurate seasonal labor-distribution data for the district specified. Similar methods could be followed in obtaining labor data for the live-stock enterprises of the farm.

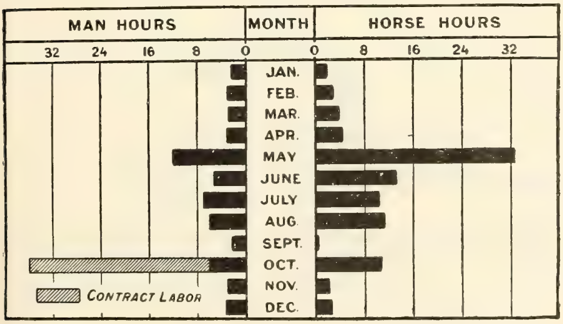

FIG. 5.—Labor distribution by months in growing potatoes in the Greeley district of Colorado.

In regions such as the irrigated-farm areas of Colorado, where there is much competition between certain crops and a variation in the crops grown by individuals, somewhat greater individual range in seasonal distribution of crop labor is shown than would be found in an area where only one important staple crop is produced. For example, one man in this region may have a large portion of his farm devoted to sugar beets, which require much labor during the harvest season in October and November, while a neighbor may grow wheat on most of his farm area and have very little crop labor in these two autumn months, which period covers the sugar-beet harvest season. Another may divide his crop acreage between numerous crops, so as to be busy during the entire growing season and at the same time not have the peak load of the labor in growing a given crop conflict with the peak load of labor for another crop. Still another may plant two crops that conflict or need attention at the same season. If a farmer plants part of his acreage to potatoes and part of it to sugar beets, he will not be able to handle so large an acreage of either crop with a given equipment of men, horses, and machinery as if he planted but one of these crops, for the irrigation and harvest dates for potatoes and sugar beets in these districts are almost identical. One variation in such a combination of crops is very common. On a farm where both potatoes and sugar beets are grown, the harvest season for sugar beets begins at a later date than on farms growing no potatoes. This is due to the fact that freezing damages potatoes more than it does sugar beets.

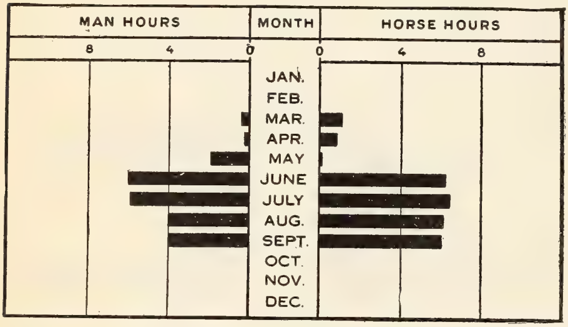

FIG. 6.—Labor distribution by months in growing alfalfa in the Greeley district of Colorado.

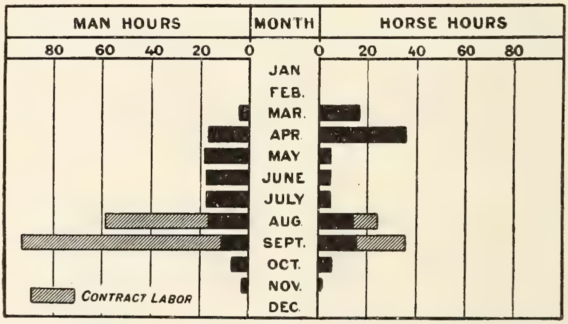

FIG. 7.—Labor distribution by months in growing cantaloupes in the Rocky Ford district of Colorado.

USE OF THE DIAGRAMS.

By the use of the accompanying diagrams and with a fair working knowledge of some of the essential agronomic practices and average weather conditions, the grower should be able to plan the acreage of each crop on a given farm with a given amount of labor so as to make the most economical use of that labor. From another viewpoint, after the selection of a certain acreage for a definite crop as the one best suited to his soil, the market conditions, and other factors that arise in its selection, the grower should be able to determine with a reasonable degree of accuracy the amount of labor he will need to hire for each month of the year and the number of work animals that will be necessary for the operation of the farm. It is shown that sugar beets require a large amount of contract labor distributed from April to November, with concentration for periods in May, June, September, and October. There are slack periods in which an interchange of labor may take place in connection with other crops on adjacent farms. In fact, this is customary in a region where competing crops are grown. To insure getting labor when needed one should keep the laborer employed on the same farm.

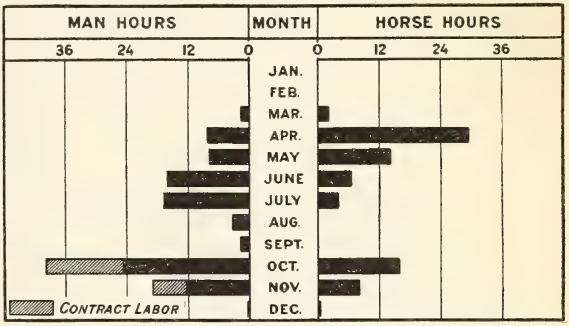

FIG. 8.—Labor distribution by months in growing cucumbers in the Rocky Ford district of Colorado.

It is also shown by the diagrams that extra man labor is needed for the grain crops at harvest time. These laborers may be used to do the contract work on sugar beets and be employed throughout the growing season, while if the beets were not grown and all the acreage was planted to grain and hay there would be a greater demand for men at grain and hay harvest time. With a limited number of helpers in the vicinity, these crops could not be handled so economically as under present conditions, because extra labor is brought in to care for sugar beets primarily, and incidentally these men are employed to help with hay and grain.

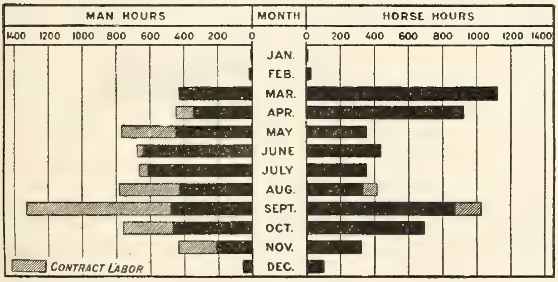

FIG. 9.—Seasonal distribution of labor required to produce 6.16 acres of beans, 20.82 acres of beets, 7.45 acres of cucumbers, 27.28 acres of alfalfa, 2.8 acres of oats, 7.85 acres of cantaloupes, and 2.05 acres of wheat in the Rocky Ford district of Colorado.

Another illustration of the use of farm help is shown when one man and four horses are needed to prepare land for wheat during the month of March and very little work has to be done on wheat in April or May, while for potatoes there is very little work in March or April, but approximately twice as much man and team labor on an acre of potatoes in May as there is on an acre of wheat in March. At the same time the sugar-beet crop requires more labor in April than either the potato or the wheat crop, and the alfalfa crop requires very little labor during March, April, or May.

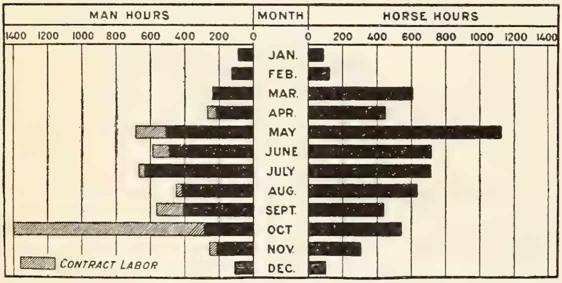

FIG. 10.—Seasonal distribution of labor required to produce 36.25 acres of alfalfa, 4.66 acres of oats, 6.89 acres of beans, 30.25 acres of potatoes, 10.49 acres of beets, 14.06 acres of barley, and 3.39 acres of wheat in the Greeley district of Colorado.

Other diagrams show the average seasonal distribution of crop labor for farms having specified acreages of different crops. These show the season when the farmer must work the most hours each day and hire the most labor.

By intelligent use of these diagrams the amount of labor required by a crop and the months when the labor is expended may be approximated closely, and many items of economic and agronomic importance to the region may be studied.

Figures 3 to 8 show the labor distribution by months on the farm crops produced in three sugar-beet districts of Colorado.

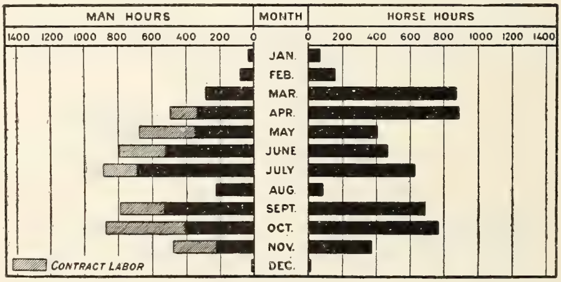

FIG. 11.—Seasonal distribution of labor required to produce 36.41 acres of alfalfa, 9.55 acres of barley, 35.93 of beets, 5.27 acres of oats, and 3.11 acres of wheat in the Fort Morgan district of Colorado.

The application of the data on the distribution of labor for each crop is made in planning the cropping system. The average acreage per farm devoted to the principal crops in the Greeley district was worked out. Using these acreages and the distribution of labor presented in figures 3 to 8, a diagram was constructed showing the monthly distribution of all the labor used in growing crops on the farm. (Fig. 9.)

To show the seasonal distribution of labor in growing all the crops of the various regions, the average acreage per farm of each crop grown was taken; also the labor required to produce the crops. From these data diagrams were constructed. (Figs. 10 and 11.)

The diagram for Greeley represents a farm of about 120 acres, the one for Rocky Ford 80 acres, while that for Fort Morgan applies to a farm with an area of about 120 acres.

FARM PRACTICE.

The average number of man and horse hours required to produce the important crops common to these districts has been compiled in Table III. These averages are given to show a comparison of the various practices for the production of the farm crops within a given region rather than a comparison of practices for any given crop common to each of the three districts. Occasional references are found concerning the differences in practice between regions, but the study is mainly devoted to the various crops in the same section.

The farm operations have been grouped under these headings: Manuring, preparation of the seed bed, planting, cultivation, irrigation, harvesting, and marketing. Contract labor is a direct cash outlay and has not been considered in totaling the hours of labor expended in producing the crops. This item has been included in considering the relative cost of the production of crops.

These major groups of farm labor may each contain one or more minor operations, which are enumerated and compared for the individual crops.

Table III.—*Distribution of labor per acre required to produce the principal crops grown in the Greeley, Fort Morgan, and Rocky Ford districts of Colorado.*

[Data expressed in hours for man and for horse.]

District and operation.	Crop and area covered by the records.													
	Sugar beets, 5,028 acres.		Potatoes, 1,302 acres.		Beans, 853 acres.		Alfalfa, 1,310 acres.		Oats, 184 acres.		Barley, 742 acres.		Wheat, 160 acres.	
	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.
Greeley district:														
Manuring	6.0	12.0	0.5	1.0	1.1	2.9	0.1	0.4	0.8	2.4	0.9	2.5	0.3	1.2
Preparation of the seed bed	8.3	30.0	6.7	27.9	6.6	24.8	.....	.....	1.9	7.0	2.5	9.5	3.2	10.7
Planting	1.1	2.1	6.8	7.5	1.2	2.2	.....	.....	1.0	2.4	1.0	3.1	1.0	3.5
Cultivation	6.5	12.3	11.9	31.2	10.2	15.3	[a].4	[b]1.5	.....	.....	.....	.....	.....	.....
Irrigation	8.5	.2	6.7	.6	5.2	.1	5.8	.5	4.8	1.1	4.7	1.0	5.0	1.0
Harvesting	[b]5.1	15.5	[b]2.2	9.1	16.0	10.1	16.0	24.4	6.7	6.2	5.5	5.2	4.7	4.2
Marketing	13.0	32.4	21.9	19.3	1.1	2.1	.....	.....	.5	1.0	.6	1.0	2.1	3.8
Total	48.5	104.5	56.7	96.6	41.4	57.5	22.3	26.8	15.7	20.1	15.2	22.3	16.3	24.4

[a] Alfalfa cultivation is practiced by a few growers.
[b] Contract hand labor on beets and picking potatoes are not included.

TABLE III.—*Distribution of labor per acre required to produce the principal crops grown in the Greeley, Fort Morgan, and Rocky Ford districts of Colorado*—Contd.

District and operation.	Sugar beets, 2,455 acres.		Alfalfa, 1,233 acres.		Oats, 144 acres.		Barley, 262 acres.		Wheat, 102 acres.	
	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.
Fort Morgan district:										
Manuring	5.1	10.5	......	......	0.9	2.1	1.1	3.4	1.1	1.9
Preparation of the seed bed	8.4	35.5	......	......	5.7	21.3	4.9	17.6	4.7	16.7
Planting	1.0	2.1	......	......	1.0	3.8	1.0	3.3	1.0	3.9
Cultivation	5.4	11.3	[c]0.1	[c]0.4	......	......	......	......	......	......
Irrigation	9.0	1.4	8.2	1.1	5.6	1.4	5.6	1.9	5.9	1.5
Harvesting	[c]4.1	12.1	18.0	26.8	8.2	9.7	8.8	10.9	10.8	12.9
Marketing	12.3	30.1	......	......	......	......	1.2	2.3	1.7	3.3
Total	45.3	103.0	26.3	28.3	21.4	38.3	22.6	39.4	25.2	40.2

District and operation.	Sugar beets, 2,429 acres.		Beans, 179 acres.		Cantaloupes, 301 acres.		Alfalfa, 915 acres.		Oats, 75 acres.		Wheat, 82 acres.		Cucumber seed, 252 acres.	
	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.	Man.	Horse.
Rocky Ford district:														
Manuring	6.5	12.8	2.6	6.5	0.3	0.5	0.4	1.6	2.6	3.0	4.0	5.3	1.8	2.1
Preparation of the seed bed	10.1	35.5	9.5	33.6	12.2	47.0	.....	.....	7.0	25.5	6.9	24.6	9.7	37.7
Planting	1.1	2.3	1.3	2.2	4.9	1.8	.....	.....	1.0	3.1	1.0	3.3	1.0	2.1
Cultivation	9.4	18.2	17.7	12.8	52.1	23.3	.....	.....	.....	.....	.....	.....	33.0	14.7
Irrigation	9.8	1.4	14.8	.2	16.0	.7	7.1	1.1	10.6	1.1	9.1	1.9	11.2	.8
Harvesting	[d]5.5	18 4	26.3	9.1	([d])	......	17.4	21.8	11.3	10.8	8.8	10.3	37.0	22.9
Marketing	13.6	44.1	1.8	3.6	14.9	28.7	1.0	1.7	.1	.1	2.7	8.0	.8	1.7
Miscellaneous[e]	.....	.....	.....	.....	3.3	3.7	.....	.....	.....	.....	.....	.....	.....	.....
Total	56.0	132.7	74.0	68.0	103.7	105.7	25.9	26.2	32.6	43.6	32.5	53.4	94.5	82.0

[c] Contract hand labor on beets is not included.

[d] Contract hand labor on beets and picking and packing of cantaloupes are not included.

[e] Miscellaneous includes work upon a building, a packing shed, laying roads, and hauling empty crates from the depot.

PREPARATION OF THE SEED BED.

The preparation of the seed bed embraces numerous distinct operations, beginning with the removal of trash from the land and including disking, plowing, rolling, spike-tooth and spring-tooth harrowing, crowning of alfalfa, scraping, and leveling.

REMOVING TRASH.

Comparatively few farmers practiced removing trash from the land. A few in the Greeley and Fort Morgan districts raked and burned potato vines from the land in preparing it for seed. Some growers at Rocky Ford raked and removed cantaloupe and cucumber vines. In most cases these vines were disked or plowed under. On the potato land the digging of the crop served as a sort of fall plowing, and the next crop was in some cases planted without plowing or disking the land. Usually, the potato vines would interfere so much with harrowing or leveling that it was necessary to remove them. Most farmers preferred to incorporate vegetable matter with the soil rather than to rake it off and burn it. Where trash was to be removed from the land the usual method was to rake it up with a common dump rake and burn it immediately. The total amount of labor expended in this operation is comparatively small.

PLOWING PRACTICE.

The benefits of fall plowing are apparent to those in these regions who grow potatoes or sugar beets, for in harvesting the crop the land is partially plowed. In the spring these fields are very easy to prepare for a seed bed, the winter's freezing and thawing having mellowed and pulverized the soil. The land usually contains moisture stored from the winter and spring rains and snows. With this example and their experience with the few fields that they have been able to get plowed in autumn or winter, most farmers believe there would be an increase in the production of their crops if they could practice more fall plowing. In fact, there is so little available time for fall plowing that only a small percentage of the grain-stubble land is plowed before spring. Some alfalfa is plowed in early winter, but the time of harvesting, especially beets and potatoes, prevents fall plowing. The acreage of these crops is usually large, so that the full season is taken in harvesting, some frost usually being in the ground before the completion of the beet harvest. The winters are seldom sufficiently warm to permit winter plowing, and frost usually remains in the ground until late March or early April. This causes a rush for the preparation of seed beds in the spring, and too often seed is planted in a poorly prepared seed bed.

Only 5 out of 57 men growing small grain at Greeley plowed in preparation for the crop. Table III shows that much of this land had been in potatoes or beets the previous year. Out of 41 men reporting, 13 plowed for grain at Fort Morgan. At Rocky Ford 50 per cent of the men growing grain plowed the land. For beets, potatoes, cucumbers, and cantaloupes nearly all used the plow in preparing the seed bed.

For such crops as sugar beets and potatoes deep plowing is necessary. With beets special care is taken to plow deeply and carefully cover and incorporate all manure and vegetable matter with the soil. Unless deep plowing is practiced for beets the beet roots are likely to be stunted and misshapen, and a low yield results. An impervious subsoil is very detrimental to the yield of a crop of beets, deep plowing tending partially to overcome the ill effects of a close subsoil. The average depth of plowing for beets in northern Colorado was between 8 and 9 inches. Rocky Ford growers reported shallower plowing for beets.

In all three regions 2-way plows are more common than the gang or sulky plows. A 2-way plow is one which has a right-hand and a left-hand plow mounted so that one can be operated at a time. (Fig. 12.) In this way the land is all turned one way by beginning at one side of a field and plowing back and forth across it. No dead furrows are made in the field, and this is very important on land that is to be irrigated. In the Greeley section practically all farmers use the 2-way plows. These are usually 14 or 16 inch plows, three or four horses being required to pull them, the depth of plowing and the condition of the soil determining the number needed. A few growers used 12 to 14 inch gang plows with 4-horse or 5-horse teams. The gang plow can be operated with less labor per acre for plowing, but it does not leave the land in as good condition for irrigation as the 2-way plow. A number of men were found who used sulky plows, but only a few used the walking type. The 2-way plow is the best for use on irrigated lands.

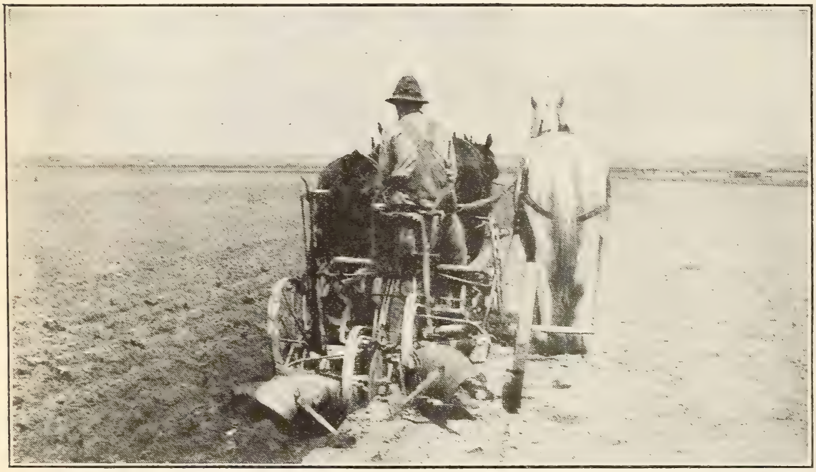

FIG. 12—Plowing with a 2-way plow. The use of this implement does away with dead furrows in the field, which is very important where irrigation is practiced.

Where alfalfa sod is to be broken for planting a crop it is customary to plow the land twice. The first operation is known as "crowning the alfalfa" or "scalping the land." The second operation is called plowing. The crowning of alfalfa is done by plowing the land at an average depth of about 3 inches, the purpose being to cut the alfalfa crowns from the taproot of the plant and to have very little root attached to the crown, so the plow is run only deep enough to prevent its shifting when large roots are encountered. To do this work the same type of plow is used as in plowing other lands. After crowning the alfalfa it is left to lie a few days or weeks so that the crowns may dry. Sometimes the land is spike-tooth harrowed, which brings the crowns to the surface, where they dry more rapidly.

When the crowns have dried, the land is then plowed 6 to 9 inches deep. This turns the crowns deeply into the ground, and in this condition they are not likely to sprout and interfere with the subsequent crop. The longer the period between the two plowings the less the number of crowns that will retain sufficient vitality to send up shoots. Where the land is plowed twice there are few plants that do not have the taproot severed. Where alfalfa land is plowed but once there is need of more work in disking and leveling to get the land in condition for a seed bed.

Alfalfa does not leave land in condition to be easily prepared for a seed bed, due to the coarse root system of the plant, but the vegetable matter of these roots contains ingredients very beneficial to the production of most crops. Beet land is left in the best state of tilth for the succeeding crop. Grain crops are often sown after beets with little further preparation of the soil for the seed bed. Grain lands are usually plowed for the succeeding crop, while potato and bean lands are often sown to grains without plowing. Cantaloupe and cucumber lands are usually plowed before planting the next crop.

DISKING.

The disk harrow is used extensively in the preparation of the seed bed for all crops in each of the three districts studied. At Fort Morgan 17 of 41 men growing grain reported the use of the disk and 19 of 66 beet growers used it. At Rocky Ford 8 of 14 bean growers, 10 of 16 cucumber growers, 100 per cent of the cantaloupe growers, 10 of 16 grain growers, and 61 of 109 beet growers used the disk in preparing the seed bed. Rocky Ford growers made a greater use of the disk than those of Fort Morgan or Greeley. At Greeley the disk was displaced by such tools as the spring-tooth harrow. The farmers at Rocky Ford use the disk to pulverize clods and to kill small weeds. There is a greater tendency for the ground to be cloddy at Rocky Ford than at Greeley or Fort Morgan, owing to the distribution of the annual rainfall. Most of the disk users at Rocky Ford plowed before or after disking, while in the northern Colorado district the disk was used more often to take the place of plowing, especially for grain crops and beans planted on potato or beet land. For pulverizing the soil in these three districts the disk is next to the plow in efficiency.

The crew for disking is most commonly one man and four horses, although a greater or lesser number of horses is occasionally used.

SPRING-TOOTH HARROW.

The spring-tooth harrow was used on approximately one-third of the beet land in the Greeley district and on 72 per cent of the grain land. This shows the importance of this implement in this region in the preparation of the seed bed. The Rocky Ford operators do not use the spring-tooth harrow much, and in the Fort Morgan region it is used only to a limited extent. In the Greeley territory it is used in the preparation of the seed bed for all crops. Its most frequent use is in preparing the seed bed for grains. On the row-tilled crops where the land is more often plowed the spring-tooth harrow is less frequently used. A spring-tooth harrow does not do its best work on land that is cloddy or rough, but it is an excellent tool with which to loosen fall-plowed or early spring-plowed lands that have become packed by heavy rains. It also works well in loose mellow fields where some weeds have sprouted. On land which has been planted to summer-tilled crops the spring-tooth harrow displaces the plow in preparing the land for grain.

The spring-tooth harrow of the Greeley region is usually in two sections, each 6 feet in width, and is commonly operated by a crew of one man and four horses. Such a crew will harrow approximately 8 acres in a 10-hour day. The average number of times this operation was performed in the Greeley region was 1.5 for beets, 1.3 for grain, and 1.6 for beans.

The spring-tooth harrow levels the land better than the disk, but does not pack the sod so much. It leaves an excellent surface mulch on the field.

ROLLING.

Smooth rollers are uncommon in the irrigated sections of Colorado, but some men make use of the corrugated roller in preparing the seed bed. Rollers are used for firming the soil after plowing and for connecting the loose surface soil with the moist subsoil. They may also be used for breaking or crushing clods. In the Greeley region rollers are used to firm and smooth the seed bed for shallow-planted seeds. With a firm upper layer of soil the drill plants at a more even depth, and the moisture rises more evenly to the surface. In this section 17 per cent of the farmers used the roller in preparing the beet-seed bed, none used it for grains, and very little use was made of it on bean or potato land.

Fort Morgan operators used the roller to some extent on beet land, but less use was made of it than in the Greeley district. No use was made of it in grain seed-bed preparation. In the Rocky Ford district some use was made of the roller on grain crops by 25 per cent of the growers. One man rolled bean land, 14 of 110 rolled beet land, and 13 of 29 cucumber and cantaloupe growers rolled the seed bed.

The common type of roller was 8 to 9 feet in length and was usually operated by one man and two horses, although sometimes as many as four horses were used. There is considerable variation in the number of acres covered, 12 to 15 being an average day's work. Usually the land is rolled but once.

SPIKE-TOOTH HARROW.

The spike-tooth harrow is used in the preparation of land for all crops. All the Rocky Ford operators except one beet grower and one wheat grower reported the use of this implement in seed-bed preparation. The use of the spike-tooth harrow was reported by 99 per cent of the beet growers in all regions. Fort Morgan grain growers reported its use on 36 of 41 fields. In the Greeley district 31 of 57 grain growers used the spike-tooth harrow, this implement being more used in this region than in any other. Bean and potato growers in Weld County commonly used this type of harrow.

The spike-tooth harrow is used in Colorado for the purpose of leveling the land, pulverizing and packing the surface soil, and destroying small weeds. Where land is plowed, it is customary to harrow the area of land plowed that day. This prevents crusting or the formation of hard clods and excess evaporation of moisture from the soil. After this first harrowing the land is usually gone over at intervals of from 7 to 10 days until the crop is planted. Beet growers went over their ground with the harrow on an average of slightly over 3 times and bean growers 2.6 times. Grain land in Weld County was harrowed with a spike-tooth implement but 1.3 times, in Morgan County 1.5 times, and in Otero County 2.3 times. Cucumber seed beds were similarly treated 3.8 times, and cantaloupe seed beds were gone over 3.9 times.

In nearly every case the harrowing was done with a steel spike-tooth harrow with a steel frame and an adjustable tooth stand. These harrows were of two, three, or four sections and ranged from 9 to 16 feet in length. They were operated by one man and three or four horses, 12 to 15 acres being usually harrowed a day. Accurate data were not obtained as to the number of men who weighted the harrows by riding, although this has much to do with the effectiveness of the operation.

LEVELING.

No operation in the preparation of a seed bed for an irrigated crop is more important than the leveling, but the amount of time put in on any one crop depends upon many factors. Among these one must consider the previous crop and the condition of the land. Another important factor is the accumulative value of previous leveling. If a farmer has been practicing careful and effective methods of handling and leveling his fields for several years, the necessity for this work becomes less each year. A field that is not properly leveled can not be properly irrigated and can not produce its maximum crop.

Leveling is done just before planting, and in the sections studied it is done best with the common box leveler. This implement is usually constructed on the farm of heavy planks set on edge. The length usually is 14 to 18 feet and the width 8 to 10 feet. Four planks are placed on edge, making the box, then one or two cross planks are inserted across the box the narrow way. The leveler takes dirt off all small knolls and ridges and deposits it in depressions. An even surface free from small depressions or knolls is thereby obtained, and even irrigation is made possible. Such a leveler is of further benefit in crushing clods and firming the land.

To properly operate one of these levelers, four horses are necessary. One man and four horses will level from 9 to 15 acres per day. Men with lightly constructed levelers usually find it necessary to go over the land a greater number of times.

Of the beet growers, 98 per cent leveled their land before planting, going over it 1.5 times in the Greeley district, 1.8 times in the Fort Morgan district, and 2.1 times at Rocky Ford. All cantaloupe and cucumber growers reported leveling their land, averaging 2.2 times for each crop. All the grain growers at Rocky Ford reported leveling, going over the land an average of 1.6 times. In the Fort Morgan district 20 per cent of the grain growers did not level their land, the others doing so an average of 1.3 times, while 44 per cent of the grain growers in Weld County did not level the seed bed for grain; those who did went over the land on an average but once. Potato land is furrowed deeply, and there is less necessity of leveling it than for other furrow-irrigated crops.

These figures show that more leveling is done in the preparation of furrow-irrigated crops than with those flood irrigated. In furrow irrigation small depressions or knolls retard the water or cause streams of water in furrows to unite, and there is a necessity for better preparation of the land for these crops.

TOTAL LABOR OF PREPARATION OF THE SEED BED.

The greatest amount of time was occupied in the preparation of beet land for seed. Alfalfa has no charge made for the preparation of the seed bed, for in all cases the crop was sown with grain and the hours of labor were charged to the crop of grain. In most instances no extra work was done on the field that was to have alfalfa sown in the grain.

Approximately the same number of hours were expended per acre in plowing for beets as for potatoes, but the time spent in leveling, rolling, and harrowing was much less for the potato seed bed. The seed bed for beets must be level, firm, moist to the surface, and free from weeds at planting time; otherwise the stand will be poor. The seed bed for potatoes does not need to be as smooth or firm or free from small weeds. Under the head of "Planting" an explanation of this difference in requirements will be given. Bean land requires approximately the same work in preparation as potato land. A somewhat better seed bed is required for beans, as they usually follow potatoes, grain, or beets; but potatoes more often follow alfalfa. The expense of plowing is less for beans than for potatoes, and more time is expended in leveling and firming the seed bed for the bean crop.

Of the grains, oats shows the least work necessary to prepare the seed bed; barley comes second; and wheat requires the greatest amount. Oats is the hardiest grain crop in all three districts.

PLANTING.

The only item of labor included in the planting of a crop is the drilling of seed except in the case of potatoes, which includes the labor of cutting the seed. Where cucumbers and cantaloupes are planted by hand the land is marked with a marker, and this is part of the labor in planting these crops.

For alfalfa there is no labor charge for planting the crop, since most growers use a combined grain drill and alfalfa seeder. Very little, if any, more time is consumed than in planting the grain crop alone. Also, since alfalfa is allowed to grow for several years, the labor of planting would add but little to the labor requirements per ton of hay. Replanting, where practiced, has been included under the planting practice.

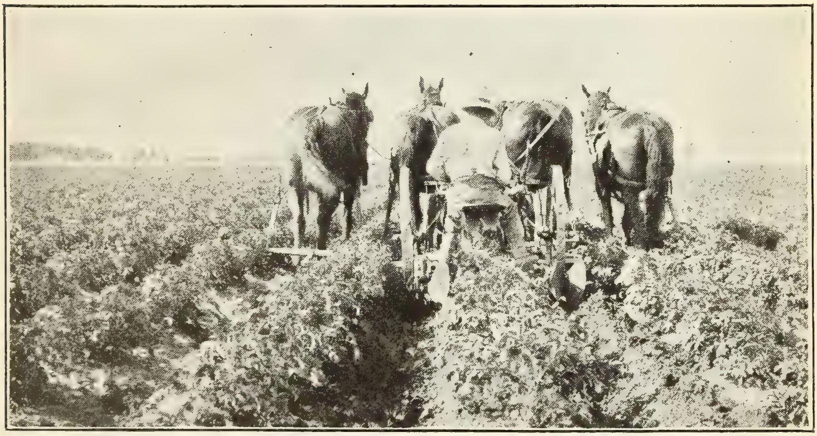

FIG. 13.—Ditching potatoes. Deep furrows are made between the potato rows, so that the surface of the water will be lower than the potatoes in the hills.

Sixty-three per cent of the man labor employed in planting an acre of potatoes is consumed in cutting the seed. The common potato planter of the region requires a 3-horse team. Most of the grain drills are for 3-horse and 4-horse teams, although some use 2-horse grain drills. Two horses are used in planting sugar beets and beans. In planting potatoes it is common to hill the row, and before the plants are up the ridge is harrowed down. This kills all the small weeds and leaves an excellent seed bed at the time that the plants appear. Some farmers ridge the bean rows immediately after planting and harrow down the ridge before the plants come through.

The older types of bean drills have no ridging attachment, but the new types have ridging tools. This method of planting and cultivating potatoes and beans eliminates much of the hand labor of hoeing. It also eliminates the danger of loss of stand from the formation of a crust on the soil. (Figs. 13 and 14.)

Approximately 1 hour of man labor is required to plant an acre of grain, beans, beets, or cucumbers for seed, 6.8 hours for potatoes, and 4.9 hours for cantaloupes. Sugar beets, beans, cantaloupes, and cucumbers require approximately 2 hours of horse labor per acre. Grains average slightly more than 3 horse-hours per acre to plant, while potatoes require the greatest amount of horse labor in planting, 7.5 hours.

In all three sections there is little variation in the method of planting beets or grain. The grain is drilled in rows 8 inches apart, the beets in rows usually 20 inches apart, although at Rocky Ford some farmers planted beets 18 inches apart and some men at Fort Morgan and Greeley alternated 16-inch and 24-inch rows. Potatoes are planted in rows 36 to 40 inches apart. Beans are planted in rows 28 to 32 inches apart. Alfalfa is scattered broadcast with a seeder or drilled in rows. Cucumbers are planted in rows 36 to 40 inches apart. Cantaloupes are planted in check-rows or hills 5 to 7 feet apart with four or five plants to the hill. Cucumbers are thinned to approximately 18 inches between plants in the row, beets 10 to 14 inches, beans 2 to 6 inches, and potatoes 18 to 24 inches.

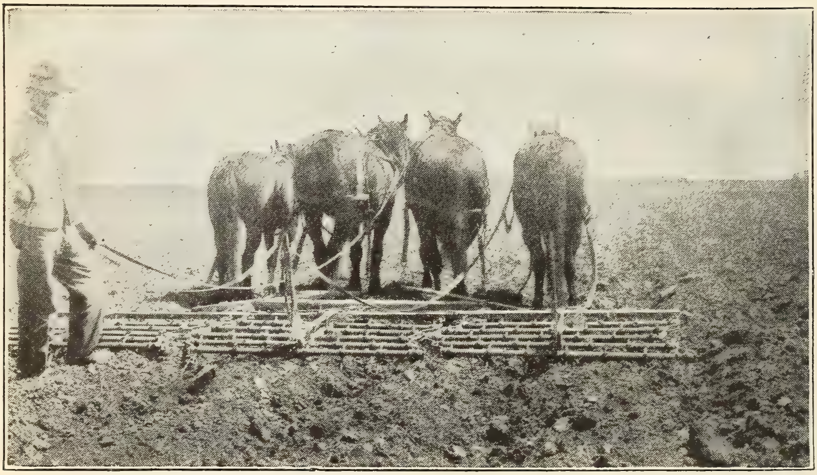

FIG. 14.—Harrowing potatoes. When the tubers are planted a deep covering is put on the seed. By harrowing, this covering is removed, leaving the ground free from small weeds when the potato sprouts come through the surface. This practice is followed in bean planting and saves much hand labor in hoeing.

The depth of planting for beet seed is from 1½ to 2 inches; for grains, about 2 inches; cantaloupes and cucumbers, about 2 inches; beans, 2 to 3½ inches; and potatoes, approximately 6 inches.

Crops are planted a few days earlier in the season at Rocky Ford than in the other districts. The dates of planting beet seed at Rocky Ford are from April 1 to June 15, at Fort Morgan from April 10 to June 22, and at Greeley from April 1 to June 20. The greatest amount of planting is done from April 20 to May 10 in each of these districts. As a rule, cantaloupes are planted from April 20 to May 10. Cucumbers for seed are planted from May 1 to June 5, the greater portion about May 25. Potatoes are planted from May 25 to June 10. The planting of winter wheat varies from August 30 to December 1 and of spring wheat from February 28 to April 15. Oats are planted from March 1 to April 15 and barley from March 15 to April 25. As a rule, barley is planted later in the season than other grains. Beans are planted from May 15 to June 10; alfalfa usually in April.

Beet seed is planted at the rate of 15 to 20 pounds per acre; potatoes, 600 to 700 pounds; alfalfa, 10 to 15 pounds; cucumbers (average), 4.5 pounds; and cantaloupes, 3.4 pounds. Beans of the type grown for seed were seeded at approximately 55 pounds, and pinto beans at the rate of 20 to 30 pounds to the acre.

At Greeley the average rate of seeding per acre for wheat was 77 pounds, for oats 75 pounds, and for barley 83 pounds. At Fort Morgan the rate was 59 pounds of wheat, 82 pounds of oats, and 72 pounds of barley. At Rocky Ford the rate was 89 pounds of wheat and 82 pounds of oats.

MANURIAL PRACTICE.

All the crops studied have some labor charge for the application of manure, although to some of the crops no direct application of manure was made. The charge is due to the cumulative value of manure in the soil. The manure value and the labor application cost are charged to the farm crops, according to the place in the rotation that the manure is applied. The schedule is as follows: 50 per cent of the value of the manure and 50 per cent of the work of applying it to the field are charged to the crop receiving the direct benefit, 30 per cent to the following crop, 20 per cent to the crop on the land the third year, no charge being made to crops farther removed from the application of the manure. If manure is applied to the same field for three successive years, the following charge will be made against the crop: 20 per cent of the cost of the first application, 30 per cent of the cost of the second application, and 50 per cent of the immediate application.

In a survey of these regions it was found that 92 per cent of the farmers applied barnyard manure to their crops, 367 growers made reports upon the use of manure, and 310 applied the manure to the beet crop. On 22 farms the manure was applied to potatoes, and on

5 it was applied to grain. These statements show that beet growers consider beets to be the crop most responsive to the application of manure. No use of commercial fertilizer was reported in these districts.

The hours of farm labor charged to manuring show that in each of the three districts studied alfalfa was the farthest removed from the manure application. In the Fort Morgan territory no manure charge was made against alfalfa, as none of the growers visited had seeded alfalfa on land that had been manured during the previous three years. Where alfalfa is put on land which has received a heavy application of manure there is an inclination toward the production of coarse hay. Manure can not well be spread on alfalfa sod, for it can not be properly incorporated into the soil and will be raked up with the hay and injure its quality. However, the principal reason for not manuring alfalfa is the better response of other crops to the manure. Instances are recorded where the average yield of beets on a field has been increased from 50 to 100 per cent with no other apparent factor for the cause of this increased yield than the application of barnyard manure. Manure can be best incorporated immediately and mixed with the soil by putting it on land which is to be devoted to a summer-tilled crop. The tilled crops of these districts are beets, potatoes, beans, cucumbers, and cantaloupes. Cucumbers and cantaloupes did not receive much manure. The men producing these crops alone, as a rule, kept few live stock, and those who grew beets and cucumbers or cantaloupes preferred to put the manure on the beet land.

After breaking out alfalfa, 75 per cent of the farmers in the potato-growing section planted potatoes. On land with so much vegetable matter in the soil from the alfalfa roots and foliage, it would not be advisable to add manure, since it would add an excess of foreign matter to the soil and make it difficult to cultivate. Some growers claim that manure applied directly to the potato crop is likely to cause an excess growth of tops or vine and also to promote disease or increase the number of rough potatoes. Likewise, beans are sometimes inclined to have excess foliage or to be uneven in maturing when heavily manured.

The grain crops do not, as a rule, respond well to a direct application of manure, as they produce a heavy growth of straw under such conditions and the crop is inclined to fall down or lodge.

Different types of soil respond differently when manured, and a crop that on one type of soil would show little benefit from an application of manure might on another type near by show greatly increased yields. However, the rule in these three districts is to put the manure on the beet crop, because the maximum production of beets is on land that has been treated with manure.

There is need of more humus in most soils in these districts. The practice of efficient irrigation requires that the soil have good water-holding capacity, and the climate of the districts is such that the humus rapidly burns out of the soil. Many farms lack a sufficient supply of manure for the land, and few farms use green crops for turning under to supply humus. Some farmers grow sweet clover and turn it under, others turn under considerable foliage when alfalfa sod is broken, but many are inclined to pasture off all alfalfa foliage before plowing the land. Beneficial results were usually reported from the turning under of alfalfa foliage, and the practice is increasing. There is a demand for more care in building up the humus content of the soils of these districts.

Manure is usually hauled to the fields at a time when teams would be idle or when the farm crops are not in need of attention. This hauling is done at all seasons of the year, but least in the late spring and summer months and most in the early spring. More hauling would be done in the winter if it were not for the heavy winds that prevail, causing the manure to drift or dry out on the soil surface. Manure should be spread and disked or plowed under immediately. Where this is not possible it is often placed in small piles over the field and spread with forks at plowing time. Another plan is to place manure in large piles on or near the field and distribute it with spreaders just before plowing. Most farmers used manure spreaders with 3 or 4 horse teams. A number of them had an extra helper to assist in loading the spreader. Where manure was left to be spread until the ground was in condition to be disked or plowed, there was need of the efficient use of the manure-spreading equipment of the farm. The hauling of manure placed in piles was usually done by one man and two horses.

Most of the manure spread was produced on the farms, but in some cases it was hauled from near-by towns and from the sugar-factory feed yards. The greatest quantity was hauled from factory feed yards in the Rocky Ford district. This practice greatly increased the labor required to apply the manure.

The greatest labor expended per acre for applying manure was at Rocky Ford, and the least at Greeley. More tons of manure per acre were applied at Greeley than in either of the other districts; the least at Rocky Ford. In the Greeley district the crews averaged larger and the distance hauled was less than at Rocky Ford. The manuring practice at Fort Morgan more closely resembles that at Greeley than that at Rocky Ford. Beet growers at Greeley manured 49 per cent of the land planted to beets, at Fort Morgan 47 per cent, and at Rocky Ford 41 per cent. Other crops had only a small percentage of the area manured.

CULTIVATION.

The cultivation practice includes all operations, such as breaking the crust (fig. 15) before the plants come through the soil, which is done by harrowing or rolling; the cultivating with common types of cultivators; furrowing and sledding for irrigation; hoeing; and miscellaneous practices employed to kill the weeds and keep the soil in a proper state of tilth. The reason for including sledding and furrowing for irrigation as parts of the cost of cultivation is that these operations, although primarily performed for irrigation, often take the place of regular cultivation.

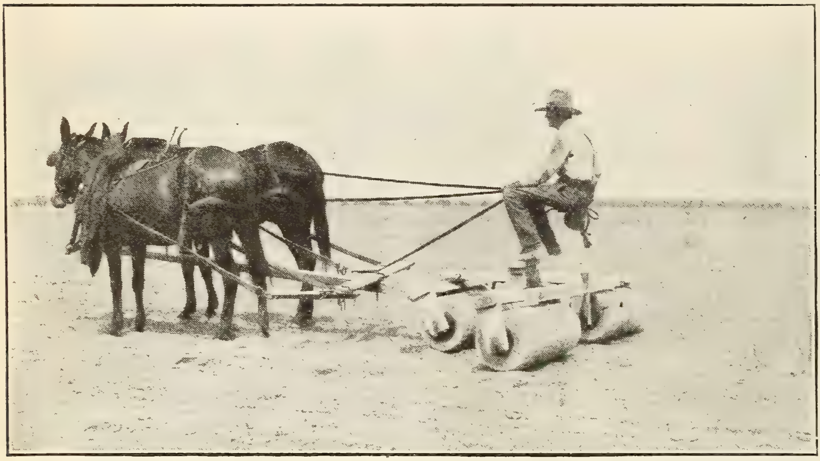

FIG. 15.—Rolling a sugar-beet field after it has been irrigated to germinate the seed.

Contract hand labor, such as for thinning and hoeing beets and picking potatoes, is not included in the hours of labor enumerated in Table III. Since this item is a direct cash outlay, it is considered under the cost of production. Where farmers have done their own hand labor, the labor hours have been reduced to their money equivalent and charged as a cash item.

On the grain crops no charge has been made for cultivation, although a few reports showed that the farmer harrowed the grain after it was planted. This operation is so closely related to the preparation of the seed bed that it has been charged to the crop under this heading.

In growing alfalfa 10 farmers renovated the crop. This was accomplished with alfalfa renovators by 5 of the men, the others using disks or harrows. Grasshopper poisoning was also included as a part of the labor of cultivating, as it is an operation which has to do with carrying the crop from planting to maturity. The grasshopper poison used was a mixture of bran, lead arsenate, and sirup. This sweetened mixture was distributed from a sack around the edges of the fields and along the ditch banks, a horse and buggy sometimes being used to carry the poison. Some crops, such as beets, sometimes have to be sprayed to kill insect pests. (Fig. 16).

Sugar-beet cultivation is well under way before beans or potatoes are sufficiently large to be cultivated. The first cultivation of beets comes before any contract labor has been done. At about the time the plants have four leaves the cultivator is run through the field. At this time the knives are used to cut along close to the row to throw dirt away from the plants. It is advisable to stir the center of the row as deeply as possible with a narrow shovel, thus keeping it from packing and enabling later ditching for irrigation to be more perfectly done. Practically all cultivating and furrowing are done with 4-row implements requiring 2-horse teams. Beets are cultivated from three to five times, such frequency apparently being essential for a maximum yield. About 8 acres is a normal day's work in cultivating beets. When the plants are small the work is done at a slower rate than later in the season. Furrowing, which is done when the plants are larger, is done at the rate of 9 or 10 acres a day. The methods of furrowing for irrigation at Rocky Ford are somewhat different from those of the two northern districts, where it is not customary to furrow except after the last cultivation. If a second furrowing is practiced it is usually done to make the furrows deeper. At Rocky Ford the first furrowing usually comes soon after planting, a second during the period of cultivation, and a third after cultivation is completed. Sledding is usually done on land that is without a slope.

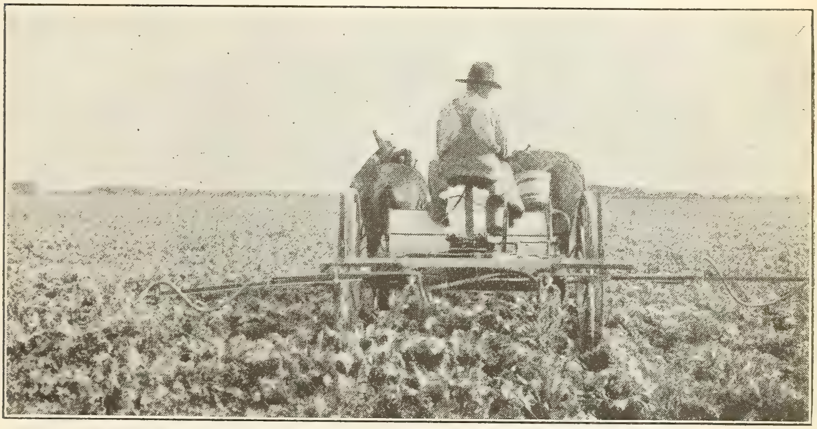

FIG. 16.—A type of sprayer used for potatoes and other field crops.

The cultivation of beans is less exacting than that of beets. The work is often done with beet cultivators adjusted to the width of the bean row and equipped with the heavier types of beet tools. Since the bean plants grow rapidly from the beginning, there is less danger of covering them than in the cultivation of sugar beets. The irrigation furrows between the bean rows are made somewhat deeper than those for beets. The cost of the horse labor required to cultivate beans is somewhat higher than for beets in the Greeley district and less than for beets at Rocky Ford. More hand work is done on beans at Rocky Ford than at Greeley, where beans are often grown without using a hoe. One man and two horses can work approximately 7 acres of beans a day, the crop being cultivated about three times and furrowed twice. A few farmers ditch alternate rows of beans with a potato ditcher and four horses. Others use beet furrowers and ditch each row or alternate rows as preferred. Very little work is done on the beans after the plants begin to bloom. Some beans grown for seed are rogued by the seedsman. (Fig.17).

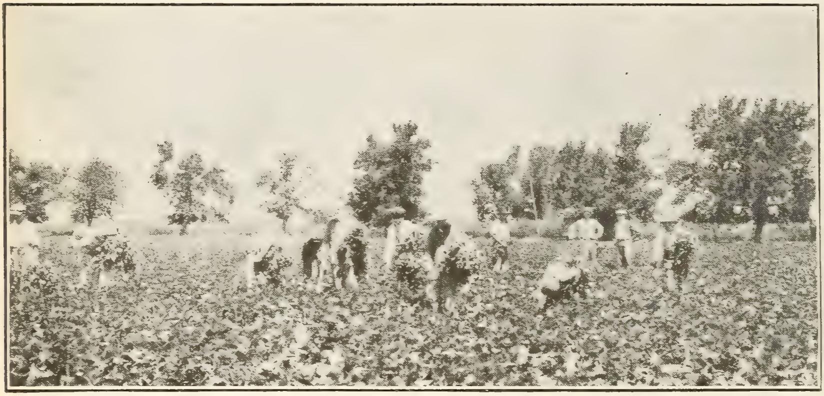

FIG. 17.—Roguing beans. These beans have been planted for seed, and the seedsman is taking out such plants as are not true to type, an important item in the production of reliable seeds.

The potato crop as studied at Greeley requires more hours of man labor in cultivation than the sugar-beet crop. The horse labor necessary in cultivating potatoes is more than twice that required for beets or beans. Harrowing with a team of three or four horses usually takes the place of the first cultivation of beans. Potatoes are harrowed before they come through the surface of the ground. The cultivation of potatoes is done with the idea of ridging the potato row very high and making a deep furrow between the rows. This requires the use of 3-horse and 4-horse teams, usually the latter.

In growing potatoes it is necessary to ridge the rows. When the crop is irrigated it is advisable to have very deep furrows between the rows, so that the water surface in the furrow is lower than the potatoes growing on the plant roots. (Fig. 18.) Beans and beets do not require as deep furrows for irrigation as potatoes. On account of the large amount of work done by contract labor in hoeing the beet crop, cultivation by the use of farm teams is greatly lessened for this crop. The contract laborers hoe the beets usually three times during the growing season. Since beans and potatoes are usually hoed by day laborers, this labor is included in the hours expended in the cultivation of these crops. The cantaloupe crop requires more horse labor for cultivation than the beet or bean crop, and the hours of man labor are very high. Hand labor is used in thinning and hoeing the crop. In laying back the vines for cultivation and in cultivating and furrowing the field the crew often consists of one man and one horse. After planting the seed, 23 per cent of the cantaloupe growers harrowed or rolled the land. The crop was cultivated from five to seven times and usually hoed (including thinning) three or four times. The irrigation furrows are made three or four times and sledded usually three times. It was necessary to lay the vines back twice for furrowing or sledding the furrows. The earlier cultivations are often done with two horses, but later it is necessary to use 1-horse cultivators, furrowers, and sleds, as the vines spread over the field surface. The cultivation of cucumbers is similar to that of cantaloupes, the same types of machinery being used for the two crops. Cucumbers grow more rapidly, and the operations are therefore less in number.

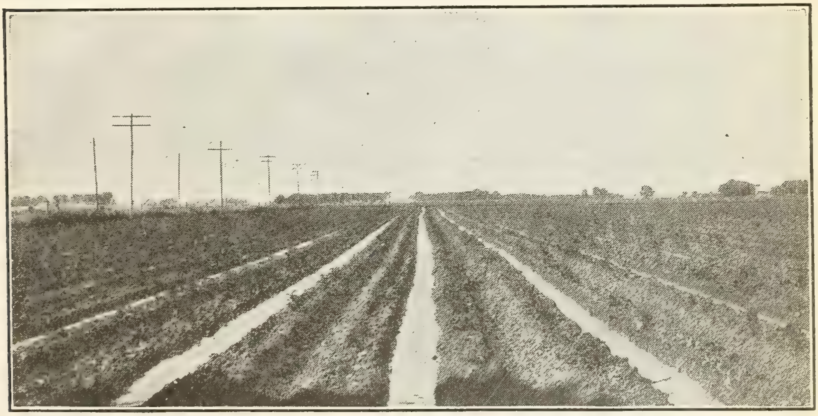

FIG. 18.—Irrigating potatoes by means of deep furrows. Only the alternate rows carry water.

IRRIGATION.

Irrigation includes the time expended in the application of water to the crop and the labor of cleaning, repairing, and making the ditches and laterals. The making of furrows between rows of cultivated crops is considered a part of the labor of cultivation.

In cleaning ditches most of the farmers had to use some horse labor. Ditches or laterals often become filled with trash and dirt, some of it being carried by the heavy spring winds. It is often necessary to use a scraper in cleaning the larger ditches. The greatest amount of horse labor in ditch cleaning is done with a V-drag, which has a long side that scrapes one side of the ditch while the other side smooths the bottom. This sort of drag saves much labor that would otherwise have to be done by hand with a shovel. (Fig. 19.)

Grain crops require another item of horse labor. After the grain is planted it is common to make cross ditches through the field so that irrigation water can get to the crop. These are made at varying intervals throughout the field, depending upon the slope of the land and the type of the soil. They must not be too far apart or too long for the even irrigation of the crop. In flood irrigation, if the field is too long too much water will penetrate the ground near the outlet from the lateral. These laterals in grain fields are made with a plow or common corn lister and are usually smoothed and banked with a V-drag. When harvest time comes they often interfere with the operation of the binder and are usually partially filled by plowing in the banks. This can often be done by using one horse and making but one round to each ditch. This practice does not break down or destroy the grain along the ditch bank, as would be done if more horses were used. This operation is best done after the last irrigation of the grain and before the ditch banks harden.

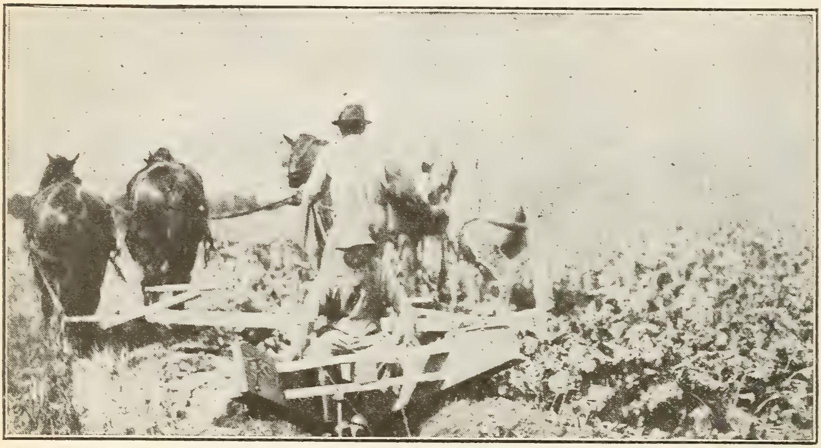

FIG. 19.—The V-ditcher. This implement is used for making new laterals or cleaning and banking old ones. It uses horses to do labor that is often done by men with shovels.

In irrigating beans, beets, and potatoes the water can be run a greater distance, as it is in a furrow and has more head. There is, therefore, often less necessity for temporary ditches through the field. Water can be run on crops by the furrow-irrigation method two to four times as far as by flood irrigation. (Figs. 20 and 21.)

Since alfalfa is a flood-irrigated crop, the ditches made in the nurse crop are usually left unfilled at harvest time or are cleaned with a V-drag and plow and thereafter each year cleaned out. There is much variation for different farms in cleaning alfalfa ditches, depending upon the type of soil and the slope of the land. Some ditches are inclined to wash clean and deep each year, but others tend to fill up.

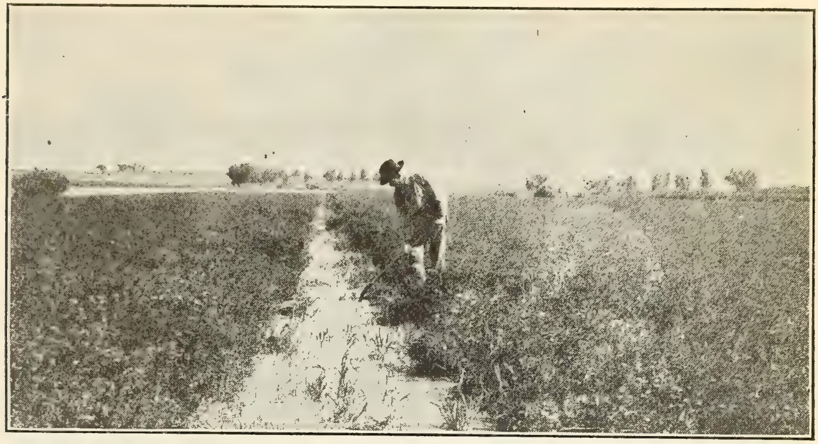

FIG. 20.—Irrigating alfalfa by the flooding method. One man can handle a large head of water.

At Greeley and at Fort Morgan the first water of the season is run on the alfalfa. The irrigation practice in these districts is very similar, but at Rocky Ford it is somewhat different. Alfalfa is usually irrigated three or four times at Greeley and at Fort Morgan, the first water being applied about May 20, the second about June 10, and the third about July 1. Where a fourth irrigation is given it is applied about July 25 or in September. This gives two irrigations before the first crop is cut and one soon after the crop is stacked. The fourth irrigation is just after the second or third crop is cut. The time per acre required for irrigation varies greatly with the flow of water, the type of the land, and the number of applications

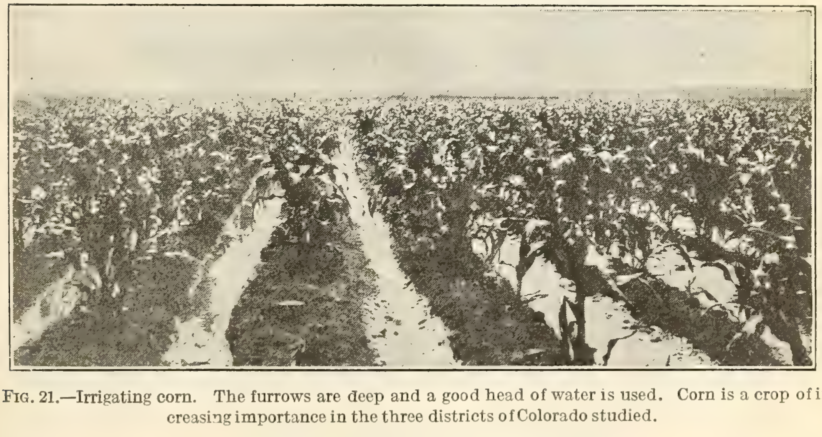

FIG. 21.—Irrigating corn. The furrows are deep and a good head of water is used. Corn is a crop of increasing importance in the three districts of Colorado studied.

given. One man will irrigate 6 to 10 acres a day. This variation holds for all crops.

The grain crops of the northern areas are usually irrigated twice—once about June 1 and again about June 20. One man will irrigate from 4 to 10 acres of grain in a day. In irrigating grain and alfalfa it is customary to let the water run on the crop 24 hours of the day. Some farmers remain continuously in the field attending to the distribution of the water, while others are so situated that the water can be set and allowed to run three to five hours without attention.

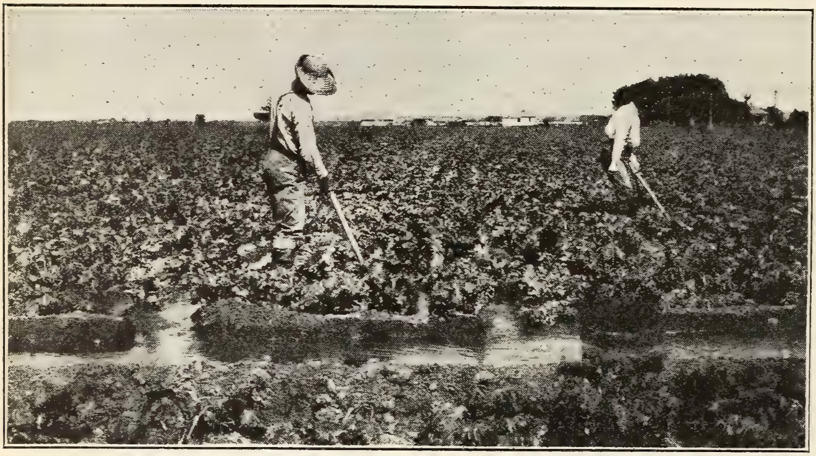

FIG. 22.—Irrigating sugar beets. This illustrates the method of letting the water out of the lateral into the furrows between the rows.

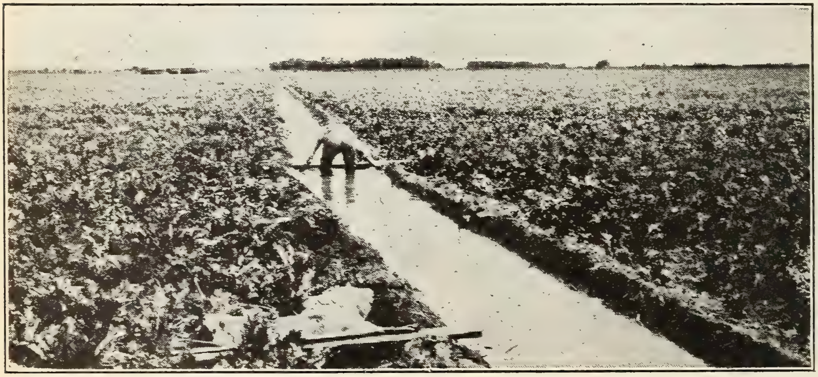

FIG. 23.—Irrigating sugar beets. This illustrates the use of canvas checks to turn the water out of the lateral into the furrows between the rows.

Row cultivated crops, such as beets, potatoes, beans, and cantaloupes, may also be irrigated by having a man in continuous care of the water or by making sets and letting the water run a few hours. This practice depends upon the head of water, slope of the land, type of soil, and length of rows. Some men prefer to run the water on row crops during the hours of daylight and turn it on the alfalfa or grain crops at night. (Figs. 22 and 23.)

The farmers of the Greeley district irrigated their beet crops three times on an average. The first irrigation came early in July, the second late in July or early in August, and the third usually early in September. The dates for irrigation at Fort Morgan are similar, but the average number of irrigations is 2½. This shows that the irrigation of grain and alfalfa is practically completed before water is put on the row crops. The irrigation of beets is delayed later some seasons than others. The water for grain and alfalfa irrigation is usually obtained direct from the supply in the rivers and streams of the region, but for irrigating row crops reservoir water is usually used, as not much water is flowing in the streams after July 1. One man will irrigate 3 to 6 acres of beets per day.

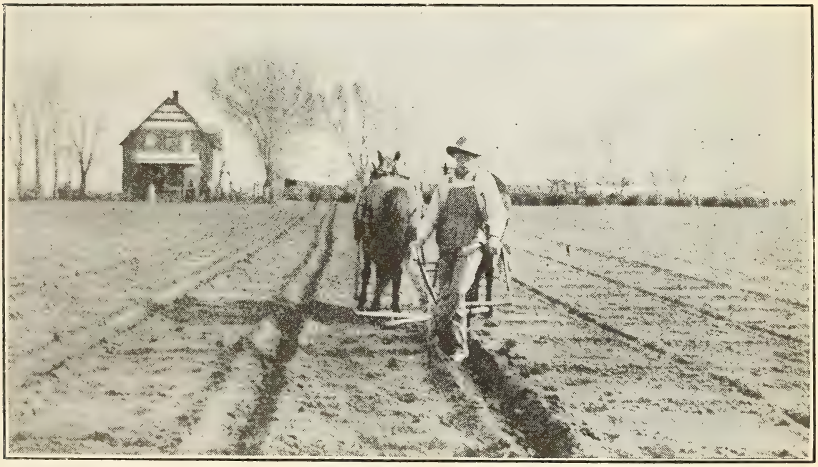

FIG. 24.—Furrowing a field prior to planting cantaloupes. Seed is planted alongside each row, and water is run through each furrow to supply moisture for germination.

Potatoes are irrigated like beets, but one man can cover more acres in a day as a rule, as the furrows are made deeper and the rows are farther apart. Water is usually run between each two rows of a row-tilled crop. Potato irrigation does not usually begin as early in the season as that of beets. The irrigation period for beans was shorter than for other row crops, being usually begun about the middle of July and completed soon after August 15. Beans are irrigated two or three times. One man can irrigate 5 to 6 acres of beans in a day, the average time per acre being 1.4 hours. Beans are usually irrigated the first time just prior to the beginning of the blooming period.

In irrigating row crops care must be taken to avoid injuring the plants. Beans should be irrigated late in the season, lest they make heavy vine growth and cause uneven ripening. Beets should not have water on their crowns. To irrigate before the crop is large enough to shade the ground causes crusting of the soil. Potatoes should be deeply ditched, so that the water will flow between the rows, the surface of the stream being lower than the location of the potatoes in the hill. Care must be taken to avoid an excess of water in the soil and to prevent heavy crusting or packing. Good subsoil drainage is necessary for the successful irrigation of all the crops studied. At Rocky Ford the climate is somewhat different from that of northern Colorado, and the crops need different care in the practice of irrigation.

FIG. 25.—The cook wagon. This is the boarding house for the thrashing crew.

Alfalfa was irrigated on an average of 3.5 times; oats, 2.6 times; wheat, 2.7 times; beans, 3.3 times; beets, 4.1 times; cantaloupes, 6.6 times; and cucumbers, 4.7 times. A man irrigating alfalfa but three times would turn on the water the first time May 1 to 15; next, June 1 to 10; and lastly, June 25 to July 5. If a fourth irrigation is given it usually comes in September, or after the last crop is harvested. Some farmers irrigate as often as six times for alfalfa. Grain, beets, and beans are usually irrigated at planting time, so as to furnish moisture for the germination of the seed. Cantaloupe and cucumber crops are irrigated to germinate the seed. Water to germinate the seed is applied to row crops by making furrows at the time of planting by attaching ditching shovels to the planter. Other irrigations are applied by methods similar to those explained for the northern Colorado regions. In the latter part of May cucumbers are given an irrigation to bring up the seed. The other waterings follow at regular intervals up to about August 25.

Cantaloupes are first irrigated when planted, usually in late April or early May. (Fig. 24.) The other irrigations are applied from 12 to 20 days apart until about August 15, when irrigation ceases.

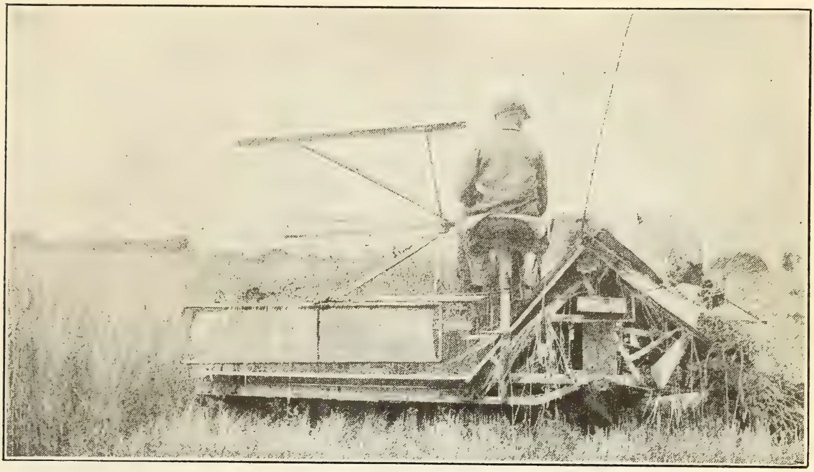

FIG. 26.—Cutting wheat.

To irrigate an acre of the crop at Rocky Ford required for cantaloupes an average of 1.6 hours; cucumbers, 1.8 hours; beans, 2.7 hours; beets, 2 hours; alfalfa, 1.5 hours; wheat, 2.2 hours; and oats, 2.7 hours.

HARVESTING.

In the vicinity of Greeley the labor requirement for the harvesting of grains is less than in the other districts because of the system used in thrashing. However, the cash expense of thrashing at Greeley is greater than at Fort Morgan or at Rocky Ford. At Greeley none of the grain is stacked by the farmer, but is thrashed

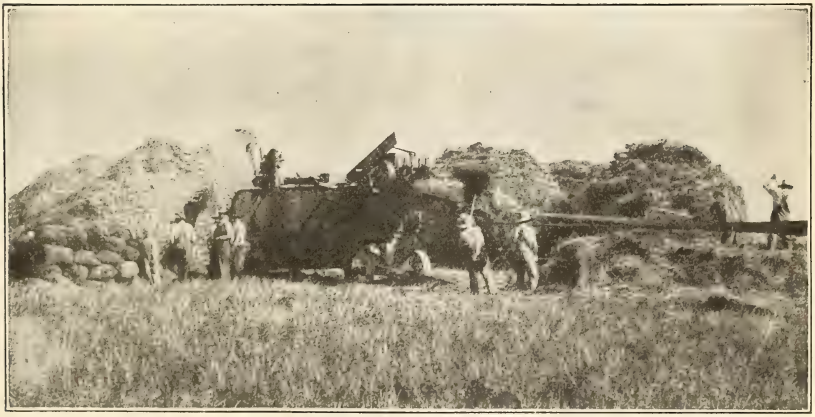

FIG. 27.—Thrashing grain.

from the shock. It is not often that much damage is done by rain to the grain in the shock. The thrashing crew consists of an engineer, separator boss, water-wagon man and team, four pitchers, and usually eight men, teams, wagons to haul the shocked grain to the thrasher, and two men to sack the grain and sew the sacks. Usually the thrashing crew is not boarded at the farm house. (Fig. 25.) The farmer has to receive the grain when sacked, pile it back from the machine, and haul it to the bin. Some farmers haul the grain directly from the field to the elevator or shipping point. In these districts the ground is usually dry and firm at harvest time, and cutting the crop is attended with little difficulty. One man and three horses constitute the most common crew, covering 8 to 10 acres per 10-hour day.

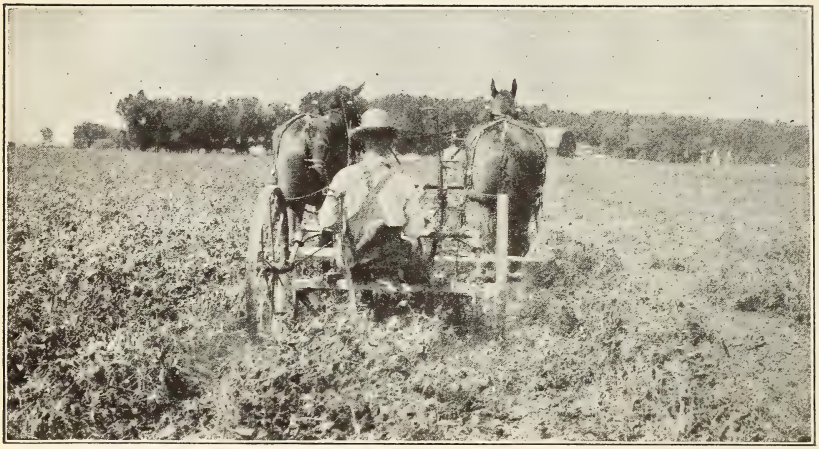

FIG. 28.—Cutting beans.

Wheat harvest begins about July 10 at Rocky Ford and extends to July 20, oats being cut from July 15 to 25. At Fort Morgan and Greeley wheat and barley are harvested from July 10 to 25 and oats from July 15 to August 1. Thrashing for grains that are not stacked begins about August 15 in these districts, but for stacked grains no thrashing is done until about September 15. The thrashing of stacked or unshocked grains is usually completed before October 1, as the beet and potato harvest begins about this date, and the cost of getting men and teams for thrashing is then greater; moreover, the farmer does not wish to do thrashing during beet-harvest time. (Figs. 26 and 27.)

The stacking of grain, which may begin a few days after it is cut, is mostly done from August 1 to 15.

Bean harvesting begins about September 1 and continues until October 1. It is done with 2-horse bean cutters. As the beans are cut the plants slide off the end of the knife and to the row center at the side of the machine. On the return across the field another row of plants is thrown in this same row center, so that two rows of beans are together. These plants are usually just matured, and with few dry pods on the plants there is no loss of beans from shelling. (Figs. 28 and 29.)

The beans are not allowed to stand in the windrow, but are bunched with a dump rake or shocked by hand the same day they are cut. The labor is lessened by shocking with a rake, but more beans are lost by shattering than where they are shocked with a fork.

Approximately half the growers thrashed the beans from the field shocks without stacking. The best practice is to stack the beans unless one is able to have them thrashed early in the fall. Where beans were stacked it was done in September with wagons and fork or with sleds, slings, and the derrick type of hay-stacking machinery. Some farmers found it necessary to turn the bean shocks before stacking or thrashing, so as to prevent discoloration of the beans. This slightly increased the shattering. Bean thrashing begins about September 1 and may continue into the winter months. The thrashers do not completely clean the beans for market, but the grower has this done at the warehouse. One man and two horses will cut 6 to 7 acres of beans in a day, and one man can shock about 2 acres in a 10-hour day.

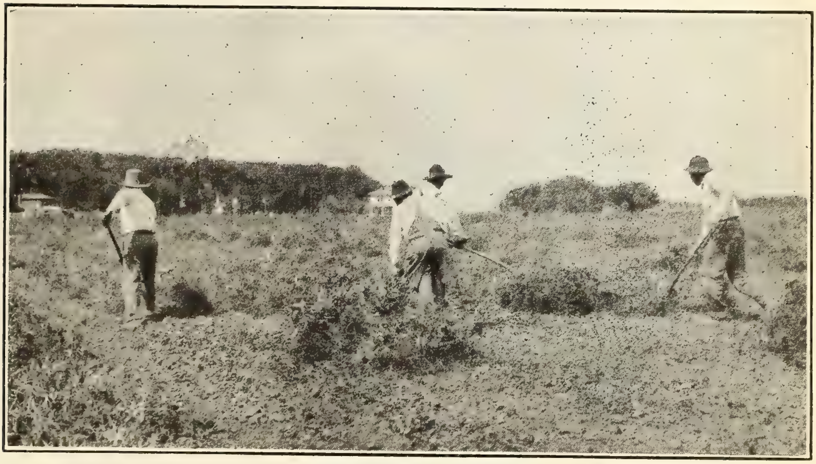

FIG. 29.—Shocking beans.

Approximately 90 per cent of the horse labor required in the production of the alfalfa crop is used in harvesting, and from 60 to 80 per cent of the man labor.

Three cuttings of alfalfa are usually made during the season. A very small percentage of the growers varied from this practice. The first cutting is made from June 15 to 20 at Greeley, the second from July 18 to August 1, and the third from September 1 to 20. These dates for cutting are approximately the same for the other regions studied.

The crew for mowing was in all cases one man and two horses, cutting from 8 to 10 acres in a 10-hour day. After mowing, it was customary to rake up the hay within a few hours, and not later than 24 hours under normal weather conditions. If hay is left in the swath more than a day the leaves become dry and brittle and break off while it is being raked, causing great loss of feed value. At Fort Morgan and Greeley almost all the farmers used side-delivery rakes, but at Rocky Ford only a few used these implements. The crew was one man and two horses for each type of rake, and by the side-delivery method 10 to 16 acres were raked in a day, while the dump rake covered from 12 to 20 acres. After the hay is raked into windrows it is bunched. The Fort Morgan and Greeley farmers did all the bunching with bunching or dump rakes, either of which is operated by one man and two horses. Such a crew can bunch 20 acres or more of alfalfa in a day. At Rocky Ford some growers bunched or shocked the hay with forks, one man handling 4 to 6 acres per day. Only a very few men did not bunch the hay before stacking it.

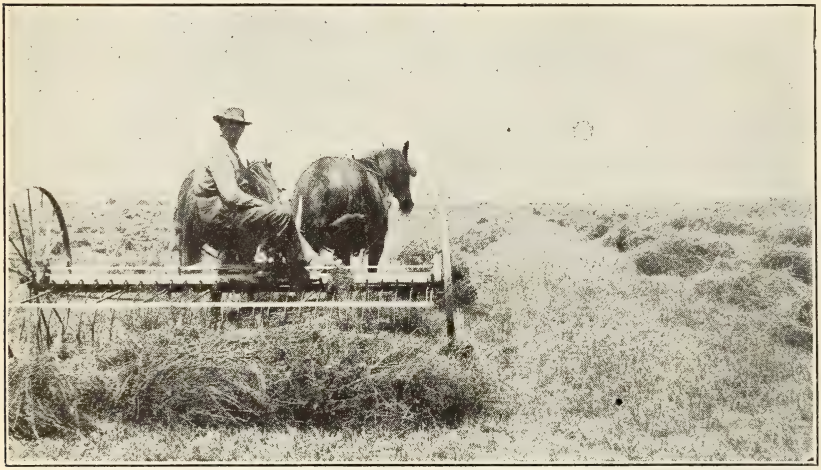

FIG. 30.—Bunching alfalfa. After the hay has been raked into windrows by the use of a side-delivery rake it is bunched.

As a rule, hay is permitted to cure from two to five days in the bunches before stacking, the methods of stacking varying greatly in the different regions and on different farms. A few farmers at Rocky Ford hauled the hay to the stack on wagons. This method is not used by those having large acreages of alfalfa. Push rakes and overshot or side-lift stackers were used by some men in each district. At Fort Morgan most of the growers used overshot stackers and push rakes, the usual crew being four or five men and five or six horses. One man and two horses operated the stacker, with one or two men on the stack. This left two men and four horses on the rakes. At Rocky Ford side-swing stackers were the most common type, the crews being the same as at Fort Morgan. The push rakes automatically load in the field and push the hay upon the stacker without any of the labor of forking. At Greeley the crew most commonly consisted of four to six men and six horses, using a crane stacker with sleds and slings. This equipment consists of two sleds or gates upon which two slings are placed, one at each end of the sled, and on these the hay is pitched in the field and taken to the stack by one man with two horses to each sled. One man stays in the field to help load the sleds. At the stack the slings are lifted by one man and two horses, one or two men being on the stack to handle the hay. Sometimes this crew varies in that three sleds are used and each team is unhitched at the stack to operate the crane, thereby using one man less. (Figs. 30–36.)

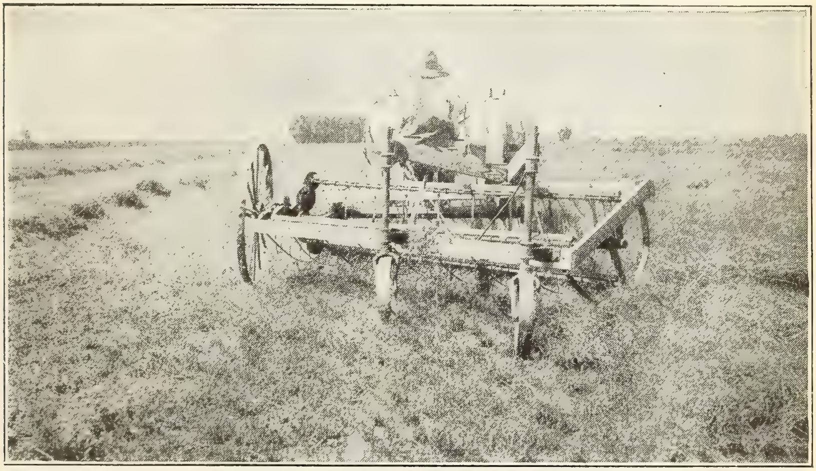

FIG. 31.—A side-delivery rake. The hay should be raked into windrows soon after it is cut or many leaves will shatter off.

The harvesting of the cucumber seed crop consists of throwing the ripe cucumbers into piles by hand, making pits for the storage of the seed before washing, then thrashing, washing, and drying.

The piling of the seed cucumbers in the field is usually done by contract at a specified price per acre, which is put under the cash cost in Table IV of this bulletin. Two men can pile about an acre of cucumbers in a day. This work is done from October 1 to 10. In a few days after piling, the cucumbers are thrashed by special types of machines which remove the seed and some of the pulp from the meaty part of the cucumber and rinds. The seed is hauled to pits and the rinds are dropped in the field near where the piles of cucumbers were.

Four men are used to fork the cucumbers into the thrasher, which is pulled about the field by two horses and is operated by a small gasoline engine. One man, two horses, and a wagon are employed in taking the seed to the pits. In 10 days to 2 weeks the seed is washed free from the remaining pulp, spread on screens to dry, and then sacked. The washing is done in a sluice box with water from an irrigation ditch. Three men do this work usually, washing 300 to 600 pounds of seed in a day. Some growers use chemical washers. (Figs. 37 and 38.)

The harvesting of cantaloupe seed is done in the same manner as cucumber seed. Cantaloupe harvesting for market is usually done on contract by Mexicans, who are paid a given rate per crate. The work of packing the melons in crates after being sorted and graded is also usually done by contract. Melons must be picked regularly. The entire field is gone over each day and the marketable ones gathered. Where possible, all ripe melons are packed and shipped the day they are picked. To get the melons from the fields, roads are made at regular intervals a few rods apart, where the vines have been laid to one side.

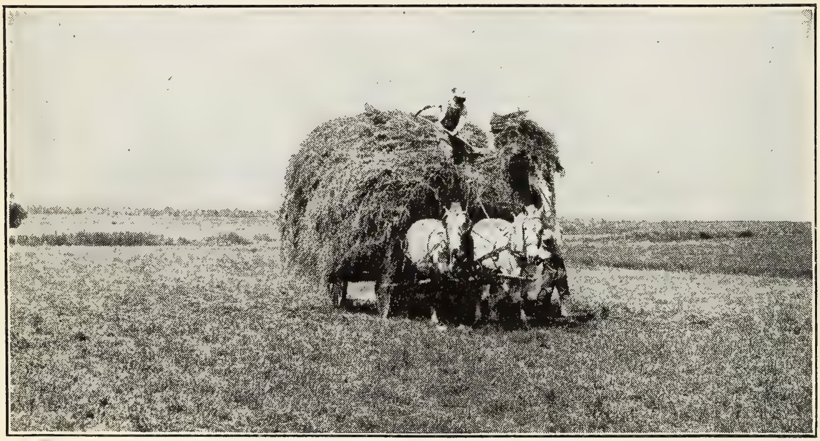

FIG. 32.—Hauling alfalfa hay from the field with a wagon. This method is too slow where a large acreage is to be harvested.

The melons are hauled to sheds to be packed in crates, which are bought and set up at a contract price. (Figs. 39 and 40.)

The potato harvest begins the latter part of September and is usually completed by the middle of October. In some seasons the potatoes are harvested later, but there is danger of the frosting of those near the surface of the ground. Potatoes are harvested by the use of diggers that dig one row at a time and drop the tubers in the furrow behind the implement. Usually the potatoes are clean and free from dirt. A potato digger requires a crew of one man and four horses, such a crew digging 4 to 5 acres in a 10-hour day. The potatoes are picked up by hand and placed in sacks or are put directly into wagons and hauled from the field to the storage cellar. If they are to be marketed they are hauled from the field to the sorter. The handwork of picking up potatoes is usually done at a contract rate per sack. Before marketing, the potatoes are run over a sorting screen, which takes out all the small ones. All imperfect tubers are picked off the screen. The potatoes are then sacked for market and usually sold in the sack. The crew for sorting potatoes usually consists of three men, one to place the potatoes on the screen and two to sort, sack, and sew the bags. This crew usually works at a contract price per sack. Sorting may be done at harvest time or during the winter or spring. It is done just before the potatoes are marketed.

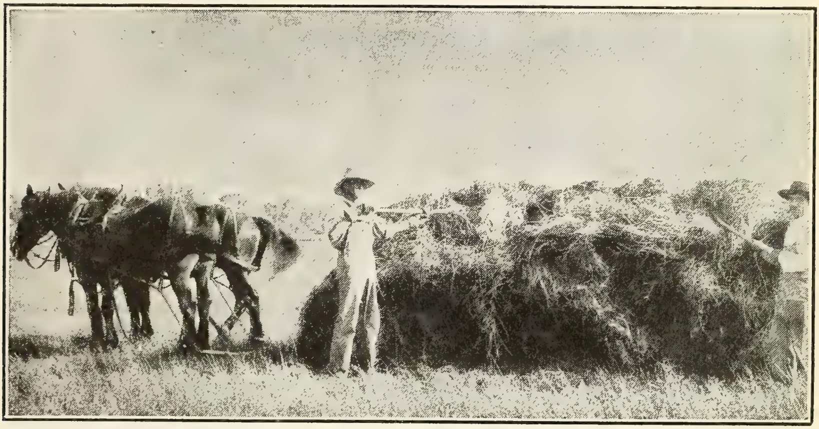

FIG. 33.—Hauling alfalfa to the stack on a sled. It is easy to pitch hay on a low carrier such as this, and very few leaves shatter off the stems. Hay slings are usually used on these sleds.

Beet harvesting begins October 1 and continues until into November, but all beets should be harvested by November 15, for if left in the ground longer there is danger of loss of the crop by freezing. Beets are harvested by the use of lifters that dig one row at a time. The beets are not completely taken out of the ground, but are lifted a few inches and loosened so that they can be easily pulled up by hand and thrown into piles. The lifters may be operated by two, three, or four horses, depending on the type and condition of the soil. One crew can lift 2 to 3 acres in a day. The piling of the beets by hand is done at a contract price per ton. After piling the beets, the contract laborer removes their tops with a hand knife. The beets are usually hauled direct from the field to market, but a very small number of growers store them in piles in the field and cover them with dirt. Beets when marketed by the usual method must be hauled within a day or two after pulling, to prevent loss of weight by evaporation. The hauling of the beets is considered under "Marketing." The beet and potato harvests come at the same time, and if a man grows a large acreage of one of these crops he can not well grow the other. The harvesting of beets may be delayed later in the season than that of potatoes, as frosting does not injure beets while in the ground. Where both crops are grown, the grower usually completes the potato harvest before beginning with beets. It is not good practice to delay the beet harvest, since bad weather may come which will necessitate additional labor in hauling the crop, and in cold weather the handwork of topping beets is very tedious. Furthermore, the beet tops have considerable value as stock feed, and if harvested late they may be partly lost on account of being covered with snow.

MARKETING.

Few farms were visited where any labor was performed in marketing hay, almost all being sold by the ton in the stack. Some farmers fed it to the stock brought to their farms and received cash for the labor of feeding in addition to the price of the hay. When the hay was hauled to another farm it was paid for at a cash price per ton in the stack.

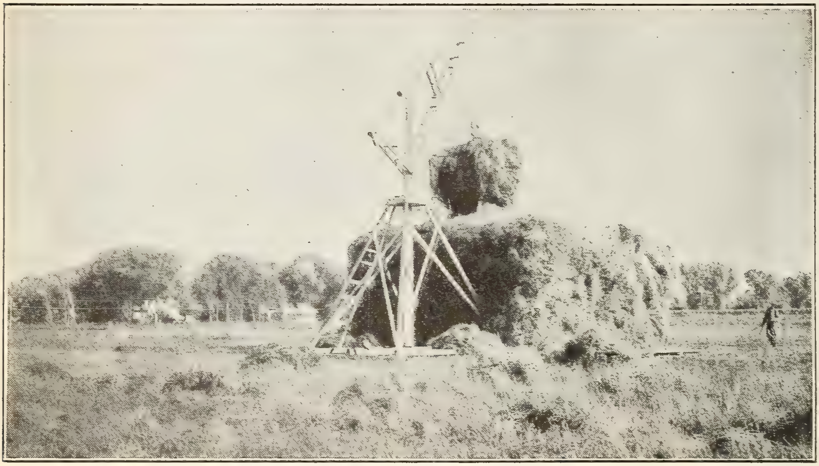

FIG. 34.—Stacking alfalfa, showing the overshot type of stacker.

Oats and barley have a very small average charge for marketing, because the greater portion of the crops was fed on the farms and the grain was delivered by the grower in but few cases.

Wheat was usually hauled to the nearest shipping point, which was often a beet siding or dump where a car was placed to receive the sacked grain. (Fig. 41.)

Beans were hauled to the nearest bean cleaner or elevator in most cases, but were sometimes marketed like wheat.

The marketing of sugar beets consists of loading them on a wagon in the field and hauling them to the nearest beet dump or receiving station, where they are either dumped or shoveled off the wagon. On an average, for the Greeley district the farmer hauled his beets 1.54 miles. Where cars are available and the yards at the factory are of sufficient capacity to receive the beets, they are dumped from special-type drop-side wagons so that they go direct into the car. This saves the labor of shoveling. Where the beets are not dumped the company receives them at the loading station and requires the farmer to shovel them into piles on the ground. Beets are delivered as they are harvested.

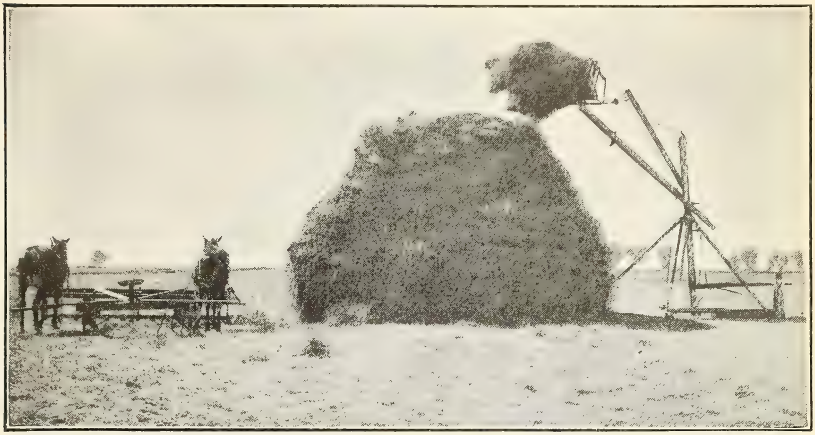

FIG. 35.—Stacking alfalfa hay, showing the side-swing type of stacker.

To market potatoes it is necessary that they be sorted, graded, and sacked. This is done by running them over a screen and picking out the damaged tubers, the smaller ones and dirt falling through the screen. A sorting crew usually consists of three men. One puts the potatoes on the sorter or screen, and two men sort them and sew the sacks. This may be done in the field at harvest time or in the potato

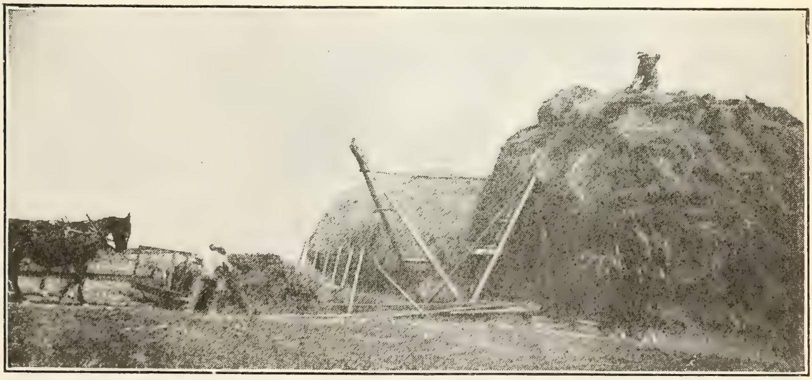

FIG. 36.—Stacking alfalfa hay, showing the derrick type of stacker and the use of sleds and slings.

cellar later, depending upon when the potatoes are sold. Sorting is always done just before the potatoes are marketed. They are hauled and sold in the sacks.

More man labor and less horse labor are required in marketing an acre of potatoes than in marketing an acre of beets.

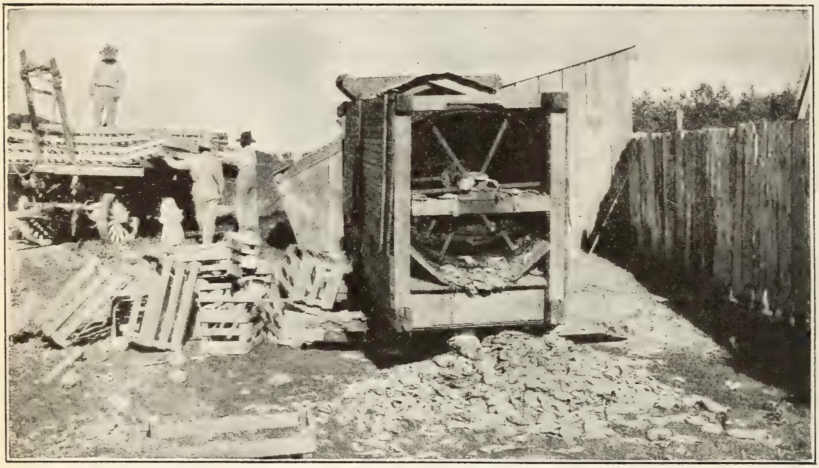

FIG. 37.—Thrashing cantaloupe seed.

Beets and cantaloupes are the only crops grown that must be marketed as soon as harvested. The other crops are marketed at a time when the field work is less pressing.

COST OF PRODUCTION.

As has been indicated, the prices of materials and the wages for labor were abnormal in 1917. These are factors which may vary appreciably from year to year. Such items as the number of hours of labor, pounds of seed, tons of manure, and pounds of twine remain fairly constant.

FIG. 38.—Cleaning and drying cantaloupe seed.

Figures on costs are used not to indicate the absolute rates per bushel or per ton in 1917, but to show the comparative cost of producing an acre of wheat and an acre of alfalfa, potatoes, beans, or beets.

FIG. 39.—A cantaloupe field, showing a roadway for hauling the melons.

Where the quantities of materials, labor, etc., are determined, the cost of producing a given crop for any year can be computed by applying the prevailing prices and wages for that period.

Costs are grouped under three headings: Labor, materials, and other costs. "Labor" includes the work performed by men and horses, whether such employment is paid for by the hour or at a contract rate. "Materials" embraces such items as manure, seed, fertilizer, and water. The item "Other costs" covers the remainder of the cost items, chief of which is the use of the land. Many charges under this group are against the farm as a whole, and the proportion of the

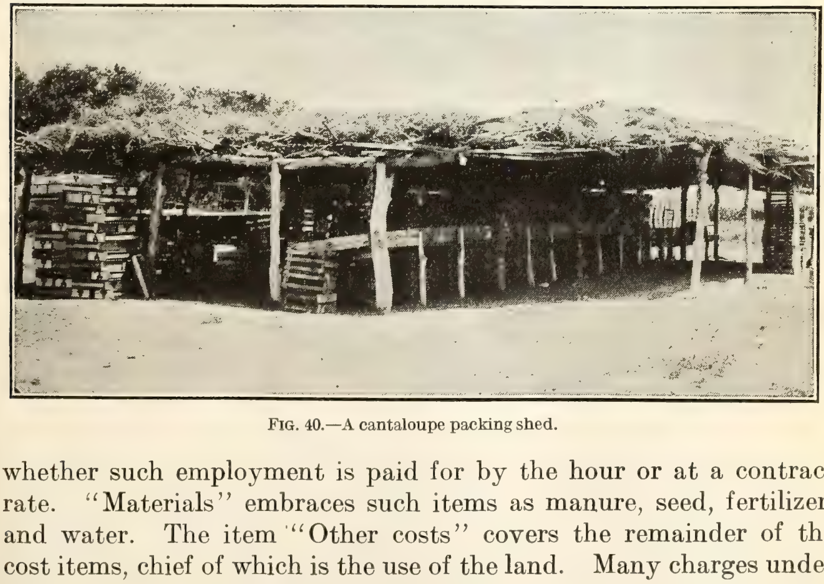

FIG. 40.—A cantaloupe packing shed.

cost applicable to a given crop must be determined by prorating the entire charge among the various enterprises involved.

MAN AND HORSE LABOR RATES.

In figuring the labor cost of producing farm crops a uniform rate per hour for man labor has been used throughout the crop season. In most sections it is customary to pay higher wages for harvesting. The average rate per hour during the entire crop year is a little low for some operations, but high for others.

Horse labor is also figured at a uniform rate per hour for the entire crop year. The average rates for man and horse labor were used in these three districts, being 30 cents per hour for a man and 20 cents for a horse.

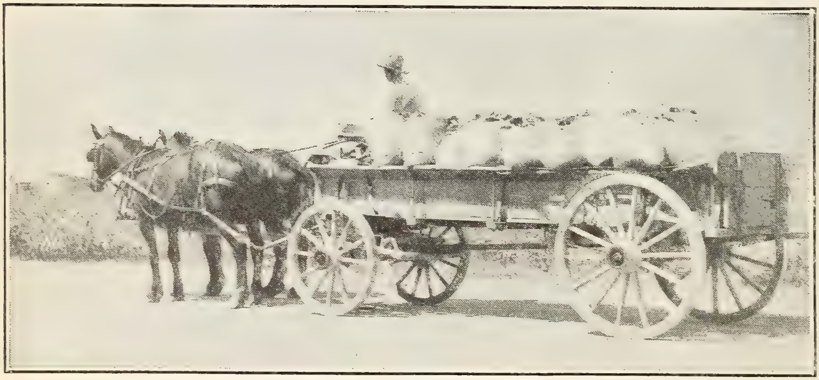

FIG. 41.—Hauling wheat to market.

LABOR.

Labor is by far the most important factor in the production of farm crops in the districts studied. Not only is the variation in the cost of production to a large extent dependent on the relative labor requirement, but the whole farming system is planned from a knowledge of the distribution of labor over the cropping season. The acreage of cultivated crops is limited by the supply of labor to take care of it during the busy periods. It is of interest to compare the labor necessary to grow the various farm crops in the regions studied.

Table III shows the hours of labor required per acre to produce farm crops in the three sugar-beet districts of Colorado considered in this bulletin.

There are usually three classes of man labor, viz, (1) work performed by the operator, (2) work done by hired labor and paid for either by the month or by the day, and (3) work performed by hired labor at a contract rate, such as handwork on sugar beets and picking potatoes. In computing the cost of production the labor cost of the third class mentioned is treated as a cash item, while the labor cost of the first two classes is found by multiplying the number of hours by the labor rate per hour.

Table IV shows the cost of the labor required to produce farm crops in the three sugar-beet districts of Colorado covered in this survey.

Under contract labor the actual amount paid out has been considered rather than the number of hours spent in doing the work. Beans, beets, potatoes, cantaloupes, and cucumbers show some contract labor, while the remaining crops do not.

There is considerable variation in the cost of labor required for the production of farm crops in the districts studied. Cantaloupes show the greatest cost ($125.16 per acre), while beets come second ($53.31 to $58.92), with cucumbers next ($51.55), followed by potatoes ($45.66). The production cost of beans is considerably higher than that of alfalfa and the grains, which show the lowest expenditure per acre for labor.

Table IV.—*Labor cost of producing farm crops in three sugar-beet districts of Colorado.*

Crop and district.	Number of records.	Crop area.	Yield per acre.	Distribution of labor costs per acre.			
				Man.	Horse.	Contract.	Total.
Wheat:		*Acres.*	*Bushels.*				
Greeley	9	160	47.4	$4.90	$4.88	....	$9.78
Fort Morgan	7	102	21.3	7.55	8.05	....	15.60
Rocky Ford	6	82	33.6	9.76	10.69	....	20.45
Oats:							
Greeley	15	184.50	61.8	4.71	4.02	....	8.73
Fort Morgan	12	144	37.4	6.41	7.67	....	14.08
Rocky Ford	10	75	54.7	9.78	8.73	....	18.51
Barley:							
Greeley	33	742	53.9	4.56	4.45	....	9.01
Fort Morgan	22	262	46.7	6.77	7.88	....	14.65
Alfalfa:			*Tons.*				
Greeley	36	1,310.50	3.43	6.70	5.36	....	12.06
Fort Morgan	34	1,233	3.36	7.90	5.66	....	13.56
Rocky Ford	25	915	3.13	7.77	5.23	....	13
Beans:			*Bushels.*				
Greeley	35	853.30	24.3	12.44	11.50	....	23.94
Rocky Ford	14	179.50	26.9	17.95	13.60	$4.27	35.82
Beets:			*Tons.*				
Greeley	195	5,028.40	15.57	16.44	20.90	17.26	54.60
Fort Morgan	66	2,455.50	13.65	19.20	20.60	13.51	53.31
Rocky Ford	106	2,428.95	12.99	18.27	26.54	14.11	58.92
Potatoes:			*Sacks.*[1]				
Greeley	44	1,802	140	17.01	19.32	9.33	45.66
Cantaloupes:							
Rocky Ford	13	301	....	34.20	22.10	42.77	99.07
Cucumbers:			*Pounds.*				
Rocky Ford	16	252	477	25.75	16.40	9.40	51.55

[1] Each sack weighing 110 pounds.

MATERIALS.

There are some materials which must be purchased; others are furnished by the farm. Such items as twine, sacks, fertilizer, coal, and irrigation water are in the first group, while manure and seed are usually furnished by the farm. Where materials are purchased, the price paid has been used in the tabulations. Materials furnished by the farm have been figured at the estimated values placed on them by the growers. The cost of materials is shown in Table V.

Table V.—*Cost of materials in producing farm crops in three sugar-beet districts of Colorado.*

Crop and district.	Number of records.	Crop area.	Yield per acre.	Distribution of the costs of materials per acre.									
				Seed.	Twine.	Fuel.	Water.	Manure.	Sacks.	Crates.	Labels.	Miscellaneous.	Total.
Wheat:		*Acres.*	*Bush.*										
Greeley	9	160	47.4	$2.20	$0.76	$0.55	$1.34	$0.30	.....	.....	.....	.....	$5.15
Fort Morgan	7	102	21.3	2.06	.73	.51	.98	1.53	.....	.....	.....	.....	5.81
Rocky Ford	6	82	33.6	3.18	.58	.46	.82	.99	.....	.....	.....	.....	6.03
Oats:													
Greeley	15	184.50	61.8	1.59	.65	.44	.83	1.32	.....	.....	.....	.....	4.83
Fort Morgan	12	144	37.4	2.09	.48	.42	1.07	1.54	.....	.....	.....	.....	5.60
Rocky Ford	10	75	54.7	2.08	.51	.39	.87	1.70	.....	.....	.....	.....	5.55
Barley:													
Greeley	33	742	53.9	1.90	.65	.36	1.24	1.42	.....	.....	.....	.....	5.57
Fort Morgan	22	262	46.7	1.83	.61	.62	.91	1.89	.....	.....	.....	.....	5.86
Alfalfa:			*Tons.*										
Greeley	36	1,310.50	3.43	.51	.....	.....	1.21	.26	.....	.....	.....	.....	1.98
Fort Morgan	34	1,233	3.36	.55	.....	.....	1.44	.....	.....	.....	.....	.....	1.99
Rocky Ford	25	915	3.13	.67	.....	.....	.96	.....	.....	.....	.....	.....	1.63
Beans:			*Bush.*										
Greeley	35	853.30	24.3	3.32	.....	.37	1.21	1.16	.....	.....	.....	.....	6.06
Rocky Ford	14	179.50	26.9	5.06	.02	.37	1.05	1.99	$1.58	.....	.....	.....	10.07
Beets:			*Tons.*										
Greeley	195	5,028.40	15.57	1.80	.....	.....	1.36	5.50	.....	.....	.....	.....	8.66
Fort Morgan	66	2,455.50	13.65	2.11	.....	.....	1.15	3.46	.....	.....	.....	.....	6.72
Rocky Ford	106	2,428.95	12.99	2.16	.....	.....	1.49	2.93	.....	.....	.....	.....	6.58
Potatoes:			*Sacks*[1]										
Greeley	44	1,802	140	31.50	.55	.....	1.36	.87	21.70	.....	.....	.....	55.98
Cantaloupes:													
Rocky Ford	13	301	.....	4.47	.....	.11	1.02	.14	.....	$44.40	$0.78	.....	50.92
Cucumbers:			*Lbs.*										
Rocky Ford	16	252	477	1.03	.....	.50	.96	1.00	.....	.....	.....	$0.84	4.33

[1] Each sack weighing 110 pounds.

Table V shows little variation in the total cost of materials required for the small grains in the three districts studied. Fort Morgan shows a high cost for manure on the wheat crop, while Rocky Ford growers spent the most money for seed wheat. On the other hand, Greeley oat producers had a lower seed cost than the others.

At Rocky Ford the cost of the bean seed was high, and there was a charge for sacks furnished by the growers. At Greeley sacks were used in hauling the beans, but they were returned to the farmer.

In the outlay for materials for the beet crop the difference is due mainly to the higher manure charge in the Greeley district.

Potatoes and cantaloupes cost about the same for materials ($55.98 and $50.92 per acre), while for cucumbers only the small charge of $4.33 per acre for materials was made.

OTHER COSTS.

"Other costs" is taken to include items which can not be considered properly under any of the preceding group headings. Many of these costs are of no less importance than those previously considered. As a matter of fact, the use of land, the largest item in this group, is larger than any other one item except labor.

Most of these costs are chargeable to the farm as a whole and must be prorated among the enterprises involved in order to determine the charge against any one crop.

Table VI gives the remaining items of cost incurred in the production of farm crops in the three sugar-beet districts of Colorado covered by this bulletin.

Table VI.—*Other costs in producing farm crops in three sugar-beet districts of Colorado.*

Crop and district.	Number of records.	Crop area.	Yield per acre.	Distribution of costs per acre.					
				Taxes and insurance.	Use of land.	Machinery.	Thrashing.	Overhead.	Total.
Wheat:		*Acres.*	*Bushels.*						
Greeley	9	160	47.4	$1.70	$16.48	$0.69	$6.20	$1.19	$26.26
Fort Morgan	7	102	21.3	1.80	17.25	.95	2.26	1.71	23.97
Rocky Ford	6	82	33.6	1.83	11.80	.67	2.32	2.12	18.74
Oats:									
Greeley	15	184.50	61.8	1.70	19.07	.69	6.30	1.08	28.84
Fort Morgan	12	144	37.4	1.80	12.16	.95	2.84	1.58	19.33
Rocky Ford	10	75	54.7	1.83	12.95	.67	2.59	1.89	19.93
Barley:									
Greeley	33	742	53.9	1.70	16.47	.69	5.94	1.17	25.97
Fort Morgan	22	262	46.7	1.80	15.03	.95	3.56	1.64	22.98
Alfalfa:			*Tons.*						
Greeley	36	1,310.50	3.43	1.70	17.82	.69	....	1.12	21.33
Fort Morgan	34	1,233	3.36	1.80	15.23	.95	....	1.25	19.23
Rocky Ford	25	915	3.13	1.83	14.88	.67	....	1.17	18.55
Beans:			*Bushels.*						
Greeley	35	853.3	24.3	1.70	18.81	2.75	4.18	2.40	29.84
Rocky Ford	14	179.5	26.9	1.83	17.87	2.67	3.93	3.67	29.97
Beets:			*Tons.*						
Greeley	195	5,028.40	15.57	1.70	14.18	2.75	....	5.06	23.69
Fort Morgan	66	2,455.50	13.65	1.80	11.55	3.80	....	4.80	21.95
Rocky Ford	106	2,428.95	12.99	1.83	17.22	2.67	....	5.24	26.96
Potatoes:			*Sacks.*[1]						
Greeley	44	1,802	140	1.70	13.95	2.75	....	8.13	26.53
Cantaloupes:									
Rocky Ford	13	301	....	1.83	13.09	2.67	....	12.00	29.59
Cucumbers:			*Pounds.*						
Rocky Ford	16	252	477	1.83	14.47	2.44	....	4.47	23.21

[1] Each sack weighing 110 pounds.

The charge for taxes and insurance is fairly uniform for all districts. The use of land varied from $11.55 an acre for beet land at Fort Morgan to $19.07 for oat land at Greeley. This item will differ according to the cash rent, the share rent, and the yield per acre. Where cash was paid the exact amount was considered. If a share of the crop was given for the rent, the farm value of that crop was used in the tabulation.

More machinery is needed for cultivated crops than for grains and alfalfa. The use cost of machinery was therefore greater for the former crops than for the latter. At Fort Morgan the highest use cost for machinery ($3.80 per acre for beets) was recorded. The use cost of machinery for grains and alfalfa was also greatest at Fort Morgan. This item in the other districts was fairly uniform.

Thrashing is partly a labor and partly a machinery charge against a crop. The portion of the thrashing labor furnished by the farmer has already been considered under "Labor costs." The charge here is the cash paid to the thrashing crew for thrashing the grain. This charge probably more nearly approaches the contract-labor classification. However, it is considered here as an individual item. The highest cost occurred at Greeley, where the yield was larger and the method of thrashing different. In this area a higher rate per bushel was paid, but more labor was furnished by the thrasher than in the other districts.

The item of overhead, which is based on the amount of labor and materials, varies with these two items. This charge ranged from $1.08 per acre for oats at Greeley to $12 per acre for cantaloupes at Rocky Ford.

The total "Other costs," with the exception of sugar beets, were highest at Greeley. Beans show approximately the same cost at Greeley and at Rocky Ford, while beets show the greatest other cost in the Rocky Ford district. Cantaloupes cost about the same as beans. Potatoes and cucumbers cost about the same as sugar beets for this item.

SUMMARY AND DISTRIBUTION OF COSTS.

When all of the cost groups are added together the sum represents the total cost of production.

A higher percentage of the total cost is shown for labor on cultivated crops than for the other crops with the exception of potatoes, the labor cost for which is 36 per cent of the total cost of production. Where the percentage of labor cost is low the percentage of other costs is high.

Alfalfa had the lowest percentage cost for materials (5 per cent) and potatoes had the highest (43 per cent).

The importance of each group as compared with the total cost of production is readily seen when reduced to a percentage basis.

Table VII shows the distribution of total cost in terms of percentages.

TABLE VII.—*Distribution of costs in producing farm crops in three sugar-beet districts of Colorado.*

Crop and district.	Number of records.	Crop area.	Yield per acre.	Total cost per acre.	Distribution of costs (percentage of total).		
					Labor.	Materials.	Other costs.
Wheat:		*Acres.*	*Bushels.*				
Greeley	9	160	47.4	$41.19	24	12	64
Fort Morgan	7	102	21.3	45.38	34	13	53
Rocky Ford	6	82	33.6	45.22	45	13	42
Oats:							
Greeley	15	184.50	61.8	42.40	21	11	68
Fort Morgan	12	144	37.4	39.01	36	14	50
Rocky Ford	10	75	54.7	43.99	42	13	45
Barley:							
Greeley	33	742	53.9	40.55	22	14	64
Fort Morgan	22	262	46.7	43.49	34	13	53
Alfalfa:			*Tons.*				
Greeley	36	1,310.50	3.43	35.37	34	6	60
Fort Morgan	34	1,233	3.36	34.78	39	6	55
Rocky Ford	25	915	3.13	33.18	39	5	56
Beans:			*Bushels.*				
Greeley	35	853.30	24.3	59.84	40	10	50
Rocky Ford	14	179.50	26.9	75.86	47	13	40
Beets:			*Tons.*				
Greeley	195	5,028.40	15.57	86.95	63	10	27
Fort Morgan	66	2,455.50	13.65	81.98	65	8	27
Rocky Ford	106	2,428.95	12.99	92.46	64	7	29
Potatoes:			*Sacks.*[1]				
Greeley	44	1,802	140	128.17	36	43	21
Cantaloupes:							
Rocky Ford	13	301	....	179.58	55	28	17
Cucumbers:			*Pounds.*				
Rocky Ford	16	252	477	79.09	65	6	29

[1] Each sack weighing 110 pounds.

TABLE VIII.—*Summary of costs in producing farm crops in three sugar-beet districts of Colorado.*

Crop and district.	Number of records.	Crop area.	Yield per acre.	Distribution of costs per acre.			
				Labor.	Materials.	Other costs.	Total.
Wheat:		*Acres.*	*Bushels.*				
Greeley	9	160	47.4	$9.78	$5.15	$26.26	$41.19
Fort Morgan	7	102	21.3	15.60	5.81	23.97	45.38
Rocky Ford	6	82	33.6	20.45	6.03	18.74	45.22
Oats:							
Greeley	15	184.50	61.8	8.73	4.83	28.84	42.40
Fort Morgan	12	144	37.4	14.08	5.60	19.33	39.01
Rocky Ford	10	75	54.7	18.51	5.55	19.93	43.99
Barley:							
Greeley	33	742	53.9	9.01	5.57	25.97	40.55
Fort Morgan	22	262	46.7	14.65	5.86	22.98	43.49
Alfalfa:			*Tons.*				
Greeley	36	1,310.50	3.43	12.06	1.98	21.33	35.37
Fort Morgan	34	1,233	3.36	13.56	1.99	19.23	34.78
Rocky Ford	25	915	3.13	13.00	1.63	18.55	33.18
Beans:			*Bushels.*				
Greeley	35	853.30	24.3	23.94	6.06	29.84	59.84
Rocky Ford	14	179.50	26.9	35.82	10.07	29.97	75.86
Beets:			*Tons.*				
Greeley	195	5,028.40	15.57	54.60	8.66	23.69	86.95
Fort Morgan	66	2,455.50	13.65	53.31	6.72	21.95	81.98
Rocky Ford	106	2,428.95	12.99	58.92	6.58	26.96	92.46
Potatoes:			*Sacks.*[1]				
Greeley	44	1,802	140	45.66	55.98	26.53	128.17
Cantaloupes:							
Rocky Ford	13	301	....	99.07	50.92	29.59	179.58
Cucumbers:			*Pounds.*				
Rocky Ford	16	252	477	51.55	4.33	23.21	79.09

[1] Each sack weighing 110 pounds.

The total cost of labor, materials, and other items in the production of various crops (Table VIII) shows a remarkable uniformity for the three areas studied. On account of the higher cost of labor and materials at Rocky Ford, there is a considerable difference in the acre cost of producing beans.

Wheat, oats, and barley cost about the same per acre. Alfalfa shows the lowest cost ($33.18 per acre at Rocky Ford) and cantaloupes the highest ($179.58). It cost more to produce an acre of potatoes ($128.17) than an acre of beets ($81.98 to $92.46). Cucumbers cost less per acre of production ($79.09) than sugar beets.

CROP CREDITS.

By crop credits is meant the value of the crop produced. If the crop is all sold off the farm, as was done with the beets, then the receipts and credits are identical. However, if the crop is partly fed on the farm or all fed to farm stock, the receipts do not indicate the total credits, and a farm value for that portion used on the farm must be assigned to the crop.

When this was done, the average crop credits per farm in the districts studied were considerably higher than the corresponding crop receipts in the same districts. The distribution of these credits among the various crops also varies widely. (Table IX.)

TABLE IX.—*Distribution of credits for the principal farm crops in three sugar-beet districts of Colorado.*

District.	Number of records.	Average crop credit per farm.	Total crop credits (per cent).										
			Alfalfa.	Wheat.	Barley.	Oats.	Beans.	Potatoes.	Beets.	Cantaloupes.	Cucumbers.	Corn.	Miscellaneous.
Greeley	53	$10,535	18.7	3.1	8.0	2.1	17.5	35.9	11.5	......	......	1.1	2.1
Fort Morgan	37	6,803	26.4	1.9	6.4	1.9	3.9	8.6	49.0	......	......	1.2	.7
Rocky Ford	40	6,982	19.6	1.9	.....	1.3	9.7	......	29.0	25.4	10.4	2.1	.6

It will be noticed that while the receipts from alfalfa were approximately 8 per cent of the total, the alfalfa credits ranged from 18.7 to 26.4 per cent of the total crop credits. On the other hand, the percentage of credits for beans, potatoes, beets, and cantaloupes is somewhat lower than the corresponding percentage of crop receipts.

It is of interest to note the distribution of crop receipts from the various farm crops. Some crops are grown primarily for sale, while only the surplus of other crops is to put on the market.

Table X gives the total crop receipts per farm and the percentage of total receipts from each crop; also the yield per acre of the principal farm crops in the three districts under consideration.

In each district there are three essential cash crops. At Greeley and Fort Morgan these crops are beets, potatoes, and beans. At Rocky Ford the potato crop is displaced by cantaloupes. These three crops bring in more than 75 per cent of all the receipts.

Although the total crop receipts per farm vary considerably, the percentage derived from the sale of alfalfa is practically the same for each district.

TABLE X.—*Crop receipts per farm and percentage of their distribution and the yield per acre of the principal farm crops in three sugar-beet districts of Colorado.*

Item and district.	Number of records.	Average total crop receipts per farm.	Distribution of total crop receipts (per cent).										
			Alfalfa.	Wheat.	Barley.	Oats.	Beans.	Potatoes.	Beets.	Cantaloupes.	Cucumbers.	Corn.	Miscellaneous.
Crop receipts:													
Greeley	53	$8,118	8.2	3.9	3.1	0.8	21.4	44.8	14.5	......	......	0.7	2.6
Fort Morgan	37	4,631	8.1	2.4	4.3	.2	5.4	12.1	67.3	......	......	......	.2
Rocky Ford	40	5,741	8.0	2.0	......	.2	11.5	......	34.1	30.7	12.7	.2	.6

Item and crop.	Greeley.	Rocky Ford.	Fort Morgan.	Item and crop.	Greeley	Rocky Ford.	Fort Morgan.
Yield per acre:				Yield per acre:			
Sugar beets....tons..	15.57	12.99	13.65	Alfalfa..........tons..	3.43	3.13	3.36
Beans.......bushels..	24.3	26.9	....	Cantaloupes.dollars..	....	217	....
Oats............do....	61.8	54.7	37.4	Cucumber seed, pounds............	....	476.7	....
Wheat..........do....	47.4	33.6	21.3	Potatoes......sacks..	140	....	....
Barley..........do....	53.9	....	46.7				

SUMMARY.

(1) The distribution of labor in the three districts in Colorado studied shows that sugar beets have a longer season of labor than any of the other crops, the grains having the shortest seasons.

(2) For the most economical production of crops and the best use of farm labor the farmer should grow a number of crops rather than one. Each farm should have some acreage devoted to the growing of alfalfa, a grain crop, and one or more of the row-tilled crops.

(3) The preparation of the seed bed is very important. Sugar beets require more labor in this respect than any of the other crops. A well-prepared seed bed lessens the labor of cultivation and is essential for obtaining a good stand and yield from all crops.

(4) The labor of planting potatoes is greater than that of any other crop studied.

(5) Manure is considered very valuable. Of the farmers visited, 92 per cent manured some land, and 84.5 per cent of these used the manure on beets.

(6) Grain crops do not respond well to the use of manure, as the straw growth is too great.

(7) Sugar beets require the most labor for cultivation because of the handwork necessary in thinning and hoeing.

(8) Cantaloupes require the most labor for irrigating.

(9) Alfalfa shows the lowest cost per acre for production, and cantaloupes the greatest.

(10) Oats, wheat, barley, and alfalfa have approximately the same requirement of horse labor per acre and the three grains approximately the same requirement of man labor to produce the crop, while alfalfa requires a somewhat greater proportion of man labor per acre. Beans require approximately twice as much man and horse labor as alfalfa. Beets and potatoes require more man labor than beans, because of the greater marketing charge, and they require about double the horse labor necessary to produce an acre of beans, four times the requirement for alfalfa, and five times the requirement for grain crops.

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
20 CENTS PER COPY
▽